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THE SULPHUR CONTENT OF ALBERTA SOILS

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In general, the sulphur content of soil is lower than the phosphorus content, and the variations in these two elements from surface to subsoil are similar; that is, the highest content is found in the upper layer of soil and accompanies the organic matter. This is essentially the case in humid climates. However, in arid regions just the reverse relationship is often encountered.

The sulphates are much more easily soluble than the phosphates and, consequently, are subject to greater movement through soils. Thus, the sulphate content of soils will, in a general sense, vary inversely with the amount of leaching to which the soil has been subjected. Sulphur may be added to soils by means of rain water in amounts varying from a few pounds to upwards of forty pounds per acre per year. On the other hand, the amount lost from the soil, due to leaching, varies in accordance with the rainfall but may be much greater than the amounts added by the rain. The excess of sulphates leached from soils over the amount added by rains would continue until an approximate equilibrium was reached. Such a tentative equilibrium would leave the soil in a condition of relatively low sulphur content.

The phosphates are never added to the soil by rain waters, and are relatively insoluble in the soil solutions. Thus, they are subjected to a smaller amount of movement in the soil and are even lost by leaching only to a very small extent. For this reason, under humid climatic conditions soils usually contain greater quantities of phosphorus than of sulphur.

Soils under an annual precipitation of thirty inches will experience a vastly different movement and loss of sulphates than similar soils under an annual precipitation of fifteen inches, and in the latter instance the rainfall may only reach a percolation depth of from three to six feet, in which case it would be expected that concentration zones of the soluble salts would still remain within the feeding range of many of the plant roots. This inverse relationship between leaching and rainfall, together with the sulphate-bearing materials of some of our western soils, accounts for the extremely high sulphur content of many of these soils.

Whenever the concentration of soluble salts becomes sufficiently high to inhibit, or prevent, normal plant growth we have what is termed "alkali" soils, and sulphate is by far the most abundant salt in the alkali soils of Alberta.

Some plants, such as certain of the legumes and the cruciferæ, require as much, or even slightly more, sulphur as phosphorus but, in general, plants require more phosphorus than sulphur.

While the composition of soils (in humid climates, chiefly) and the requirements of plants may be said to be similar as far as sulphur and phosphorus are concerned, there is not necessarily a similarity between sulphur and phosphorus problems as related to soil fertility. Stewart *(5)* has concluded that in relation to soil fertility the sulphur problem is in no sense similar to the phosphorus problem, but rather similar to carbon, since both sulphur and carbon are supplied to the plant from the atmosphere. On the other hand, a number of other investigators *(1* and *2)* have concluded that the sulphur problem in relation to soil fertility is as great as, or even greater than, the phosphorus problem, especially in restricted districts and for certain soils.*

It is not the intention of the present paper to present conflicting data on the sulphur question, but rather to submit data showing the sulphur content of soils from the various parts of Alberta, and to draw attention to the relatively high sulphur in our soils as well as to the fact that under certain conditions crops may be successfully grown on soils extremely high in sulphate sulphur, especially where sulphate occurs chiefly in combination with calcium (gypsum).

The following tables show the variations in sulphur as well as several other constituents for representative samples of soil from the brown soils (plains) belt, the black soils (park belt) and the wooded belt of Alberta.† The data for total sulphur‡ and phosphorus for the non-alkali soils from these three major soil belts are assembled in Table 1, whereas Table 2 contains data for total sulphur together with water-soluble sulphur, calcium, magnesium and water-soluble alkali salts for alkali soils. Table 2 includes samples from only the brown soils belt, since alkali soils are more extensive here than in either the black soils belt or the wooded soils belt. However, the alkali salts in the alkali soils of the latter two belts is quite similar to those reported from the brown soil belt.

From Table 1 it may be seen that the non-alkali mineral soils in Alberta vary from about 320 to 710 parts of sulphur per million in the surface soil, whereas the variation in phosphorus for these same samples ranges from 380 to 1250 p.p.m. On the other hand the sulphur in the lower layers of soil is at times much greater than the phosphorus (see samples 19, 104 and 208 which contain several times as much sulphur as phosphorus).

The organic soil (108) contains more sulphur than is found in the surface of any of the mineral soils.

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* Powers reports that there are at least 100,000 acres of alfalfa in Oregon that can be increased by one ton or more each year from treatment with sulphur at a cost not exceeding one dollar for the sulphur applied per each ton of increase in hay.

† Brief descriptions (7) of the soils of these major belts are to be found in Abstracts of the Proceedings of the First International Congress of Soil Science. Commissions V. and VI. Washington, D.C., June 1927.

‡ Total sulphur was determined by fusion of the sample with Na_2O_2 according to the method described by Wolkoff (*6*).

TABLE 1.—*Total sulphur in Alberta, non-alkali soils, (per cent water free soil).*

Sample No.	Location	Depth in inches	Total SO_3 %	Total S %	Total P %
	Black Soils of the "Park Belt"				
17	Waterhole (Peace River)	0–7	.176	.070	.103
18	" "	7–20	.142	.056	.086
19	" "	20–40	.617	.246	.090
259	Edmonton	0–7	.161	.064	.125
260	"	7–20	.073	.029	.078
261	"	20–40	.110	.044	.081
	Soils of the "Wooded Belt"				
399	Hoadley (podsol-like)	0–7	.081	.032	.038
108	Duffield (peat)	0–6	1.825	.730	.158
107	" (peat)	6–18	.785	.314	.138
	Brown soils of the "Prairie Belt" (plains)				
136	Lethbridge	0–7	.108	.043	.062
137	"	7–20	.089	.035	.068
138	"	20–40	.076	.030	.063
102	Claresholm	0–7	.149	.059	.068
103	"	7–20	.094	.037	.062
104	"	20–40	.525	.210	.065
206	Vulcan	0–7	.179	.071	.060
207	"	7–20	.117	.046	.063
208	"	20–40	1.061	.424	.054

DISTRIBUTION OF SULPHATES AND LIME CARBONATE IN SOILS

It is quite common to find a zone of sulphate concentration from three to four feet below the surface for the plains soils, but less common for the black soils and the wooded soils. (See samples 19, 104 and 208, Table 1). In certain areas, especially for the plains soils, two or even more zones of sulphate concentration may be encountered. The sulphate concentration and the depth at which such zones occur are influenced to a larger extent by the texture and nature of the soil material as well as by the amount of rainfall. In regions where the parent material, especially shales, are relatively near the surface (within a few feet), the soils are almost invariably relatively heavily charged with sulphates. We have encountered crystals of selenite of varying sizes and dimensions in numerous places in shales from certain geological formations where the weathered or partly degraded shales form a contact between the developed soil above and the parent material below. There is no doubt that these shales have been at least one of the sources of sulphates in such soils. It is rather fortunate that soils having the shales near the surface constitute only a very small proportion of the total area of the Alberta plains. However, where the glacial mantle is thicker the soils may be relatively low in sulphates, and in fact many of these soils are relatively low in total water-soluble salts.

The average annual precipitation for the plains belt (brown soils) varies from 12 to 15 inches; that of the black soils and the wooded soils belts varies from 15 to 18 inches. Evaporation is greater in the plains belt and the organic matter content of the soils less than for the other two belts. This tends to reduce the efficiency of a unit of rainfall in the plains belt. Thus the amount of leaching is not directly proportional to the rainfall. The result of leaching in the various soil belts is more uniformly and dis-

tinctly shown by the depth of the zone of lime carbonate accumulation, than by the zone of sulphate accumulation, since sulphate is not as uniformly a constant constituent as is carbonate. The zone of sulphate accumulation may or may not be identical with the lime layer; however, in general, the zone of sulphate concentration is slightly deeper than the lime layer. In the plains belt the lime layer is encountered from 9 to 24 inches beneath the surface. whereas it is respectively 30 to 45 inches in the black soils and usually more than 48 inches deep in the wooded soils.

Sulphate Content of Alkali Soils

Certain local areas may be fairly heavily charged with alkali salts and continue to produce crops under dry farming conditions, whereas when subjected to irrigation an excessive alkali condition is produced. The composition of soils from two such areas is reported in Table 2 (samples 366 to 370 and 100 to 105). The excessive salts in the soils of both these areas are largely the result of accumulations caused by irrigation waters. Samples 206 to 208 in Table 1 at present produce excellent crops, but undoubtedly disastrous alkali conditions would develop in a very short time if this soil were subjected to irrigation, since a considerable part of the sulphate present is in combination with sodium. A large proportion of the sulphate in samples 366 to 370 and 100 to 105 is likewise in combination with sodium. On the other hand, samples 384 to 391 are relatively productive, despite the fact that they contain apparently excessive quantities of soluble sulphates and have been irrigated for 8 years*. This is owing to the fact that the sulphate occurs chiefly in combination with calcium (as gypsum) and that only a small amount of water-soluble sodium is present (note the ratio of CaO to SO_3 in these samples as compared with similar ratios for the Brooks and

Table 2.—*Total and water soluble sulphur and alkali in Alberta alkali-soils. Brown soils of the Plain's Belt. (Per cent water free soil).*

Sample No.	Location	Depth in inches	Total SO3 %	Total S %	Water Soluble SO3 %	Water Soluble CaO %	Water Soluble MgO %	Water Soluble Total Salts %
384	Tilley	0–6	.076	.030	trace	.043	trace	.159
385	"	6–18	.118	.047	trace	.038	.010	.148
386	"	18–36	1.754	.701	1.129	.732	.206	2.349
387	"	36–60	3.028	1.211	1.526	.775	.165	2.746
388	Tilley	0–6	.115	.046	trace	.043	.013	.131
389	"	6–18	.134	.053	trace	.032	.005	.085
390	"	18–36	1.544	.617	1.080	.651	.173	1.995
391	"	36–60	.814	.325	.496	.237	.077	1.004
366	Brooks	0–6	2.764	1.105	1.872	.253	.092	5.044
367	"	6-18	3.124	1.249	1.955	.296	.073	4.879
368	"	18–36	4.320	1.728	2.034	.570	.300	5.868
369	"	36–54	4.181	1.672	1.610	.608	.057	5.071
370	"	54–72	3.147	1.258	1.420	.625	.066	4.273
100	Gleichen	0–12	5.611	2.244	.587	.132	.067	1.06
101	"	12–24	.795	.318	.427	.078	.050	.82
102	"	24–36	.954	.381	.389	.082	.101	.73
103	"	36–48	1.448	.579	.626	.153	.151	1.12
104	"	48–60	1.472	.588	.596	.169	.134	1.05
105	"	60–72	1.335	.534	.598	.182	.134	1.07

* For additional discussion of the alkali salts in soils at Tilley see papers by Shutt (*4* and *5*).

Gleichen samples). The presence of relatively large amounts of $CaSO_4$ in most of the alkali soils of Alberta tends to minimize the toxic effect of the sodium salts and crops seem to tolerate a relatively large quantity of salts under such conditions. The alkalinity of water extracts of these alkali soils is much lower than would be expected and consists chiefly of the bicarbonate alkalinity. The total alkalinity of these water extracts seldom reaches .1 per cent and is generally less than half this amount. This further tends to ameliorate the toxic effect of the alkali salts.

Alberta Soils Apparently Not Deficient in Sulphur

No experimental work has been done to show the effect of applied sulphur upon soils from the plains belt, but we have applied sulphur, both in the elemental form and as sulphate of potassium, to the black soils and the wooded soils, and have obtained no increases in yields for any of the crops used (wheat, oats, barley and sweet clover). If any of our soils needed sulphur it would seem reasonable to expect responses in crop yields when this fertilizer was applied to the wooded soil (see sample 399, Table 1), since the soils of the wooded belt are lower in sulphur than other Alberta soils. Consequently a series of experiments was conducted with this soil, but we failed to obtain any influence on yields for any of the crops here used (wheat, barley and sweet clover). The black soils, next lowest in sulphur, likewise gave no increases for either sulphur or K_2SO_4 applications.

Investigators from a number of different States have reported decided increases in crop yields as the result of applications of sulphur or sulphate fertilizers, but such increases in crop yields have almost invariably been obtained from soils lower in sulphur than are our Alberta soils.

Table 3 shows the relative variations in sulphur content of the surface soils from five different States and from Alberta. It may be seen that the Alberta soils in general contain more sulphur than do the soils from any of the States mentioned. However, it should be kept in mind that Illinois, Kentucky, Wisconsin and parts of Washington and Oregon are under a heavier rainfall than occurs in Alberta and in the former mentioned places the soils have been subjected to greater leaching than has taken place under our lower rainfall. When we further consider the fact that a zone of sulphate concentration is often encountered within the reach of crop roots in Alberta soils, it is to be expected that the application of sulphur or sulphates would not increase crop yields.

Table 3.—*Variations in sulphur content of surface soils from various regions. (parts per million)*

Region	Authority	Variation in sulphur parts per million
Illinois	Stewart, DeTurk, et al.	300 – 600
Kentucky	Shedd	180 – 500
Wisconsin	Hart and Peterson	200 – 600
Washington	Olson and St. John	123 – 486
Oregon	Powers	50 – 500
Alberta—		
Non-alkali	Wyatt and Doughty	320 – 710
Alkali	" "	300 – 22,440

Summary

1. In regions of semi-arid climate the sulphur content is often greater than the phosphorus content and in such soils the sulphur usually increases with depth. This condition is found in many of the soils of Alberta. Just the reverse relationship is found in the soils of humid climates, where the highest sulphur content is found in the layer of soil containing the highest amount of organic matter.

2. Soils in humid climates experience a vastly different movement and loss of sulphates than do soils under an annual precipitation of 12 to 18 inches (precipitation for Alberta), and in the latter instance the rainfall may only reach a percolation depth of from 3 to 6 feet, in which case it would be expected that concentration zones of soluble salts would still remain within the feeding range of many of the plant roots. This inverse relationship between leaching and rainfall, together with the sulphate-bearing materials of some of our Alberta soils, accounts for the high sulphur content of many of these soils.

3. The non-alkali mineral soils in Alberta vary from 320 to 710 p.p.m. of sulphur in the surface soil, whereas the variation in phosphorus for these samples ranges from 380 to 1250 p.p.m. On the other hand, the sulphur in the lower layers of soil is at times much greater than the phosphorus (see samples 19, 104 and 208, Table 1, which contain several times as much sulphur as phosphorus).

4. It is quite common to find a zone of sulphate concentration from 3 to 4 feet below the surface for the brown (plains) soils, but less common for the black (park) soils and the gray (wooded) soils. In certain areas, especially for the plains soils, two or even more zones of sulphate concentration may be encountered.

5. The zone of sulphate concentration may or may not be identical with the lime layer; however, in general the zone of sulphate concentration is slightly deeper than the lime layer. The result of leaching in the various soil belts is more uniformly and distinctly shown by the depth of the zone of lime carbonate accumulation, than by the zone of sulphate accumulation, since sulphate is not as uniformly a constant constituent as is carbonate.

6. Sulphates constitute the chief salts in alkali soils of Alberta. The sulphur content of representative soils from such areas is reported in Table 2. When the sulphates occur chiefly in combination with calcium (gypsum) and only a small amount of water soluble sodium is present (note ratios of CaO to SO_3 in samples 384 to 391, as compared with similar ratios for the Brooks and Gleichen samples), the soil remains relatively productive even under irrigation. The alkalinity of water extracts of these alkali soils is much lower than would be expected, and consists chiefly of the bicarbonate alkalinity. The total alkalinity seldom reaches .1 per cent and is generally less than half this amount.

7. Experiments with the gray (wooded) and black (park) soils of Alberta have given thus far no increases in yields for the following crops;

wheat, oats, barley and sweet clover, when these soils were treated with elemental sulphur and K_2SO_4.

8. Alberta soils are relatively well supplied with sulphur (see Table 3) in the surface layers and often abundantly supplied in the lower layers (Table 1, samples 19, 104 and 208).

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AN INDEX TO SELECTION WORK WITH AWNLESS BROME GRASS

R. A. Derick*†

(Received for publication January 25, 1928)

The following data were gathered together as an initial step in the economic improvement of commercial brome grass and it is hoped that the findings set forth in this short article may be useful to others working with this crop.

Brome grass, being a cross fertilized crop, naturally has very wide extremes of variation in many of its characters. The possibilities of at least temporary improvement are therefore very great, provided we can purify our selections without sacrificing too much through loss of vigor from selfing. As far as the writer is aware, it has not been definitely shown in any previous work with this crop that self fertilization in itself actually reduces vigor although Kirk‡ states that while a reduction in yield is apparent with selfed strains of brome grass, yet this may partly be due to 'conscious selection of plant propagants'. Selection work with any of the open fertilized crops can best be accomplished with a thorough knowledge of the interrelationship of characters, particularly those characters that are most closely associated with yield. A knowledge of the association of characters not only permits a more intelligent selection, but also may tend to save considerable time and expense in searching for the strain which carries the most desirable combination of characters.

Material Used

The material used for this work was grown at the Dominion Experimental Farm at Brandon, Man. It consisted of nine strains of brome grass, each with approximately 60 plants spaced four feet apart each way.

The strains used were as follows:

1. McKenzie strain, which represented the general run of commercial brome grass seed obtained from the A. E. McKenzie Seed Co. at Brandon, Man., in 1926.
2. M.A.C. strain, a selection made at the Manitoba Agricultural College for lack of extensive root system.
3. Superior strain, obtained from the University of Saskatchewan. This strain represents commercial seed that had been certified as being free from *Agropyron repens*.
4. N. D. 1528, 1693, 1694, 1695, 1737 and 1740 are six strains obtained from Professor Waldron at the North Dakota Agricultural College.

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† The writer wishes to thank Dr. G. P. McRostie, Dominion Agrostologist, for helpful suggestions concerning this work, and also Mr. C. Doxtator of the Manitoba Agricultural College for assistance in obtaining this data.

‡ L. E. Kirk, Scientific Agriculture, Vol. VIII, No. 1.

Procedure

The seeds were started in the hot-bed and the seedlings transplanted into the field early in June 1926. In all there were 585 seedlings put out and out of this number 530 grew to maturity and were studied during the second year.

In September 1926 notes were taken of the number of fertile culms per plant produced the first year of growth.

During the early summer of 1927 the following characters were studied on each plant:—Date headed, total number of culms at harvest time, the spread of the base of the plant and the green yield.

In taking the date of heading, some difficulty arose as to when the plants could be called "headed". Eventually, however, it was decided to call a plant headed when approximately 50 per cent of the culms had heads showing through the sheath.

Actual counts were made on each plant to determine the number of culms. In recording this data, all culms were counted that had reached a height of approximately one foot.

The spread at the base of the plant was obtained by measuring the diameter of the base on the ground level. In cases where the plants had grown to irregular shapes, the measurement was taken at the widest part.

The yields were all taken within a period of three days. The plants on the whole were slightly more mature when cut than they should have been had they been cut for hay.

Co-efficients of correlation between yield and other variable characters in Awnless Brome Grass.

Strain	No. fertile Culms 1st year	Date headed	Spread of base of plant	No. of culms at heading 2nd year
McKenzie's	.495 ± .077	.151 ± .088	.690 ± .046	.717 ± .043
M.A.C.	.142 ± .110	.103 ± .089	.601 ± .058	.652 ± .052
Superior	.425 ± .089	.006 ± .092	.788 ± .035	.752 ± .039
N.D. 1528	.099 ± .090	.163 ± .086	.728 ± .041	.683 ± .047
" 1693	.119 ± .107	.006 ± .088	.782 ± .034	.626 ± .053
" 1694	.487 ± .092	.033 ± .087	.653 ± .049	.873 ± .020
" 1695	.477 ± .072	.040 ± .087	.723 ± .041	.759 ± .036
" 1737	.377 ± .078	.195 ± .082	.801 ± .030	.738 ± .038
" 1740	.404 ± .083	.081 ± .084	.920 ± .013	.849 ± .023

It is evident from the above results that there is a strong correlation between yield and number of culms at heading the second year and also between yield and the spread of the base of the plant. It is to be expected however that the number of culms and the spread of the base of the plant would influence the yield in no small degree, and so the figures presented merely confirm general observations.

When date headed is correlated with yield there is no evidence of an association. This may be due in part to the narrow limits of variation in the date of heading of awnless brome grass as is shown below in a frequency curve fitted to two of the strains used. (See Fig. 3). Earliness in some other

crops has been shown to be rather closely related to low yield, but with brome grass this relationship apparently does not exist.

The foregoing table also shows that the number of fertile culms produced the first year of seeding cannot always be used as an index to the yielding power of any particular strain.

The correlation coefficients between fertile culms the first year and yield are extremely inconsistent when the different strains are compared. These results may show that the character for fertile culm production the first year is strongly inherited and that the inconsistencies as shown by the figures are due in some measure to unconscious selection for an extremely heterozygous character.

Effect of Selection on Variation

When we examine the amount of variation in the above mentioned characters for certain of the strains, the results show the effect of selection.

Only two strains will be used to bring out this point, namely the McKenzie strain and the M.A.C. strain. The former, as has already been mentioned, is from ordinary commercial seed, while the latter was originally selected for the purpose of reducing the extensiveness of root system, the development of which is a common fault with this crop on heavy land.

Figures 1, 2, 3 and 4 picture the actual extent to which these two strains vary for the four characters mentioned above.

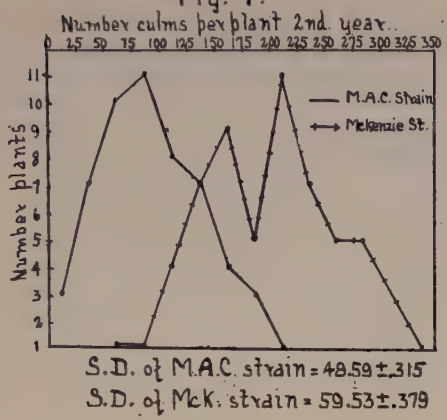
The M.A.C. strain shows a much smoother curve for the characters—number of culms the second year and the spread of the base of the plant—than does the commercial strain. Since both of these characters are correlated with yield, it is natural to expect that the M.A.C. strain would show less actual variation than the non-selected strain. This fact is also shown in the Standard Deviation of the two strains.

The extent of variation for the character 'date headed' has not been affected by selection in the M.A.C. strain since there appears to be no relation between this character and the spread of the base of the plant. On the contrary, the limits of variation seem to have been widened as a result of selection when compared with the commercial strain.

Figure 4 shows the comparative variability between the same two strains for the character of number of fertile culms the first year. The M.A.C. strain is here shown to be somewhat less variable. Whether this is significant with this strain or not is doubtful, since no association is apparent between this character and those correlated with yield.

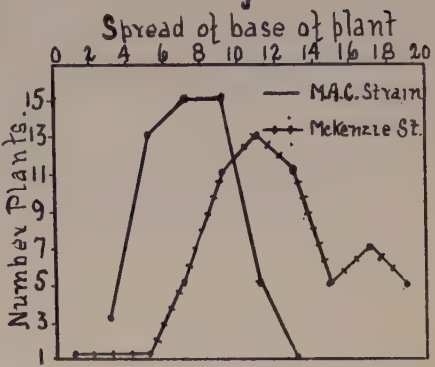
Selection within very heterozygous material might however, tend not only to effect the normal associations with other characters, as has been stated previously, but also reduce the amount of variability at the same time.

Fig. 1.



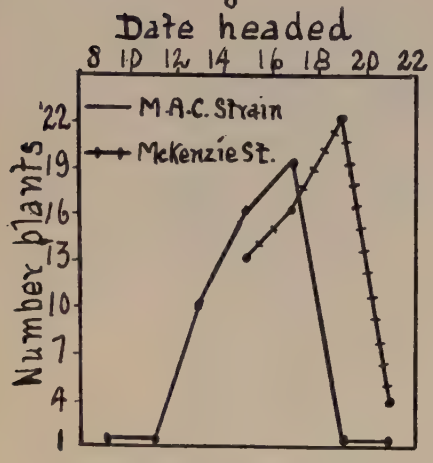
S.D. of M.A.C. strain = 48.59 ± .315
S.D. of McK. strain = 59.53 ± .379

Fig. 2.



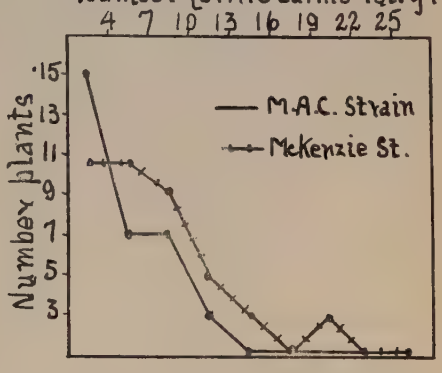
S.D. of M.A.C. strain = 2.22 ± .143
S.D. of McK. strain = 3.87 ± .224

Fig. 3.



S.D. of M.A.C. st. = 2.31 ± .147
S.D. of McK. st. = 2.10 ± .134

Fig. 4.



S.D. of M.A.C. st. = 4.84 ± .385
S.D. of McK. st. = 6.20 ± .451

Summary

1. Strong positive correlations exist in awnless brome grass between (1) number of culms at heading the second year and yield, (2) between spread at the base of plant and yield.

2. No correlation exists between date of heading and yield.

3. The association of the character for number of fertile culms produced the first year with yield has shown to be inconsistent when several strains are compared.

4. The degree of variability, as well as the mean of certain characters referred to in text, can be changed by selection.

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EXPERIMENTS IN THE CONTROL OF THE ROUND-HEADED APPLE TREE BORER (*Saperda candida* Fab.) WITH CALCIUM CYANIDE.

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(Received for publication March 19, 1928)

The round-headed apple tree borer (*Saperda candida* Fab.), present in the province of Quebec, at least, wherever apple orcharding is practised, is a most destructive pest. In one orchard at Hemmingford, comprising 2,140 apple trees, there were 1,118 infestations, but the most serious losses occurred in an orchard at Rougemont in which, in a block of 900 trees, 528 had been killed and 111 severely infested by this insect. These examples illustrate the economic importance that the round-headed apple tree borer may attain under the common orchard practices of the province of Quebec. The insect is a serious pest in many other apple-growing sections of North America but at present detailed data as to the degree of importance are not at hand.

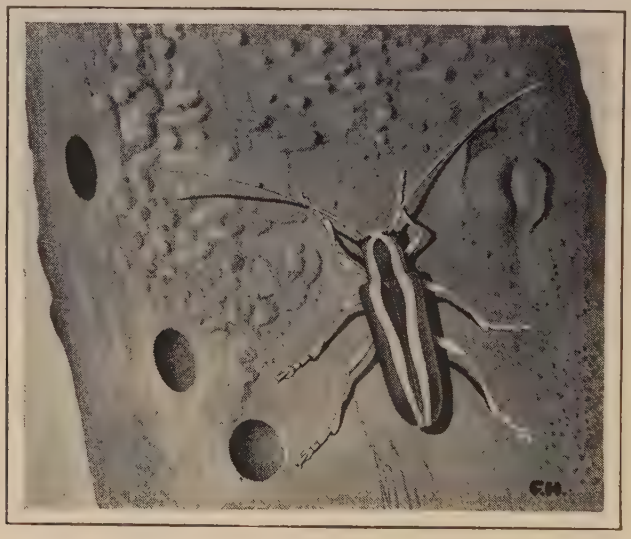

Figure 1. Round-headed apple tree borer.

The parent of the round-headed apple tree borer is a very handsome beetle (Fig. 1). The whole insect, appendages included, is clothed with a velvet-like coating of smoothly laid hairs. The antennae are nearly as long as the body. The head and ventral portions of the body are of a beautiful silvery-white and from the white face two broad white stripes extend backward over the head, across the thorax and along the wing-covers to their tips. The general color of the wing-covers and dorsal portions of the thorax is light brown. The black eyes are very conspicuous on the white head and the legs are gray.

The adult matures within the pupal chamber and emerges through a circular hole cut in the bark. It is supposed that most of the beetles

emerge during June and July in the Province of Quebec. The adults do slight damage by feeding on the twigs and on the stems and midribs of the leaves. They vary in length from five-eighths to seven-eighths of an inch exclusive of the antennae. The eggs are laid in incisions in the outer bark of the trunks and oviposition usually begins within a week or ten days after emergence. Some observers estimate the number of eggs laid per female as between fifteen and thirty. The males fly considerable distances but the females pass their lives within a few rods from where they emerge.

The larva, or borer, (Fig. 2), is a whitish or yellowish footless grub, with brown head, black jaws and broad thorax. It measures, when full grown, from three-quarters to a little over an inch in length. The body tapers gradually from just behind the head to the posterior end and the segments are decidedly constricted but the general appearance is cylindrical.

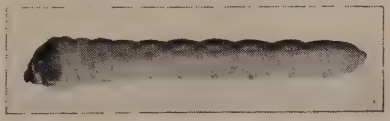

FIGURE 2. Larva or borer of round-headed apple tree borer.

On hatching the young borers promptly attack the inner bark, where they continue to feed in shallow flat burrows until late in the season; the winter is passed in these burrows. They resume feeding in May of the following year, now attacking the solid wood almost exclusively, and in young trees penetrating to the centre. The second winter is passed in the burrows and the following year feeding is continued. When nearly mature they work out to the surface, then retreat about half an inch and block the tunnel before and behind them with sawdust preparatory to pupation.

In newly infested trees the injury is usually not detected until the second year. The presence of borers in an orchard is indicated by retarded growth and the yellowing of the leaves of infested trees in the latter part of the season. If the infested trees are examined near the base, discolored, sunken, cracked patches of bark indicating the burrows beneath will be found. Reddish castings, which are forced out through small holes near the base of the tree, will be present and on examination there may often be found round holes about the size of a lead pencil in the trunk a few inches above the ground through which the adults have already emerged. The burrows, or tunnels, begin in the bark and sapwood but soon extend for several inches up and down in the solid wood. Trees of all ages, from nursery stock to large orchard trees, are attacked but those from three to ten years old suffer most. The borers work mostly in the base of the trunk, often below the surface of the soil, and in large roots, but occasionally they infest the upper portions of the trunk. If this species is abundant and neglected in young apple orchards, practically all the trees will be killed or injured beyond recovery before they are ten years old. One borer may kill a tree and three borers can easily do so. Young trees are often almost severed by them near the surface of the ground. In older

trees the injury is not always fatal but the growth of the tree and fruit is greatly retarded.

In 1923, several of the better known remedies were tried with moderate success. Unfortunately, none of the methods was easily applied or effective and up to that time no satisfactory chemical for its control had been recorded.

The recently successful use of calcium cyanide against several species of insects and other animals led the author to consider it as a possible killing agent for the round-headed apple tree borer. On July 19, 1926, six infested trees were treated with powdered calcium cyanide and a similar number with granular calcium cyanide. On August 10, 1926, ten infested trees were treated in each experiment. The method of application and the quantity of cyanide used by bulk were the same in all experiments. A teaspoonful of calcium cyanide was thrown against the tree above the castings and then a trowelful of earth was placed over the cyanide. The trees were examined the following day and the borers were removed. From the trees treated with calcium cyanide powder 22 dead borers were removed and only 1 live borer was found. There were five trees in which the borers were not located, due to the fact that any further mutilation of the trees would have caused serious injury. These trees, however, were examined several times later in the season and no new castings were observed. From the trees treated with granular calcium cyanide 13 dead borers were removed and two were found alive above the point where the poison was applied. There were five trees in which the borers were not located but these were examined several times during the season and no new castings were observed, so it may be assumed that the borers succumbed.

The positive indications of control from these experiments led to an enlarged group of experiments in 1927, as follows:—

Experiment 1.—Digging out vs. calcium cyanide on young borers.
" 2.—Digging out vs. calcium cyanide on old borers.
" 3.—Calcium cyanide—Period for Control.
After 1, 3, 6, 12, 24, and 48 hours' exposure.
" 4.—Survival of borers, after exposure to calcium cyanide for a period of two weeks.
" 5.—Effect of calcium cyanide on old borers without dirt cover.
" 6.—Effect of calcium cyanide applied with a bellows duster against old and young borers.
" 7.—Effect of calcium cyanide-flour-water paste on old and young borers.
" 8.—Effect of calcium cyanide—castor oil paste on old and young borers.
" 9.—Effect on young borers of covering their burrows with shellac.
" 10.—Potassium cyanide vs. calcium cyanide in the control of old borers.

The idea in experiment 1 was to find the relative speed with which young borers could be dug out with tools, as against treatment with calcium cyanide. Thirty trees were examined in each lot and it required

two and one-half times as long to remove the young borers as to treat a similar number. Experiment 2 was similar to the above except that old borers were worked with and the number of trees in each lot was reduced to 20. The time required to treat 35 borers was 35 minutes, an average of a borer per minute, whereas it required 250 minutes to remove 27 borers, an average per borer of 9.26 minutes. These figures clearly demonstrate the value of calcium cyanide treatment as a saver of time.

In experiment 3 an attempt was made to discover the length of time required for calcium cyanide to kill both old and young borers under field conditions and the results were as tabulated below:

Length of treatment in hours	Per cent. of old borers killed	Per cent. of young borers killed	No. larvae involved
1	0.0	15.8	58
3	16.6	4.0	68
6	82.3	87.5	49
12	93.3	100.0	32
24	100.0	(omitted)	20
48	82.6	43.6	94

The above figures show clearly that there is very little killing in the first few hours after treatment whereas both old and young borers succumb very rapidly about the sixth hour. The results tend to indicate that either the gas is evolved slowly during the first few hours after application or the larvae require a certain amount of the liberated gas before succumbing to it.

Experiment 4 might reasonably be included in the previous experiment as it merely lengthened the period of treatment to two weeks, the idea being to see whether a prolonged period of application would increase the effectiveness of the poison. Of the young borers, 32.2 per cent were killed, and of the old borers 88.2 per cent. By comparing these figures with those in the previous experiment it is seen that there was no benefit from using a more lengthy period of treatment.

In treating the old borers with calcium cyanide the material was always liberally covered with soil. If the soil was not necessary then its omission would reduce the amount of labor involved by at least one-half, so in order to ascertain this point 30 borers were treated with 1 teaspoonful of calcium cyanide with the dirt cover omitted. The borers were removed 12 days later but only 33.3 per cent had been killed. This mortality was very definitely below those experiments where the dirt cover had been used. Apparently, covering the poison with soil is essential to obtain satisfactory results. (Expt. 5).

Calcium cyanide was applied with a bellows duster to increase the rapidity of application but the mortality of 28.8 per cent and 33.3 per cent respectively of old and young borers was so low as to preclude the use of the duster. (Expt. 6).

Calcium cyanide does not stick to bark very well and the lower killing power on young borers may be attributed to this factor. To overcome this deficiency it was decided to mix the poison with some carriers possessing adhesive qualities and which would be safe to apply to the bark. Flour and

Fig. 3

Fig. 4

FIGURE 3. Beetle exit holes. FIGURE 4. Showing tunnels and girdling near the base of tree, caused by larvae or borers.

water were made into a thin paste and the poison added. The results were surprising, because instead of obtaining a smooth paste, there was great effusion and liberation of gas from the bubbles. Upon the application of a lighted match the gas burned with a dull blue flame. The mixture was applied to the trees without injury but the value of the poison must have been seriously interfered with, because only 28.8 per cent of the young borers and 33.3 per cent of the old borers were killed. The composition of the gas formed by this mixture was not studied. (Expt. 7).

Another mixture comprised calcium cyanide and castor oil mixed to the consistency of thick paint. The consistency was obtained by adding the poison to the castor oil until the desired density was achieved. The mixture was then smeared over the area indicated by the castings by means of a small paint brush. In contrast to the results received in experiment 7 the control obtained was 90.9 per cent of the young borers and 73.3 per cent of the old borers. These results appear even more successful

when it is considered that rain started 12 hours after the application was made and the fall was one-third of an inch, followed by one-twenty-eighth of an inch the following day. The trees have been examined many times since the application but no injuries to the bark have so far been observed. This mixture was found superior to all other forms of application in subsequent experiments. (Expt. 8).

It was thought to be possible to suffocate the young borers by coating over their burrows with shellac but almost total negative results were obtained since only 3.7 per cent of the borers were dead when removed. (Expt. 9).

Potassium cyanide was used in place of calcium cyanide at the rate of one-half ounce per tree but in every case the trees as well as the borers were killed. (Expt. 10).

In order to obtain the full benefit from this remedy the material must be applied before the adults start to emerge. The first adults emerged this year on June 10 from the south and south-east portions of the trunk following a rapid rise in temperature to 83°F. from the previous relatively low seasonal temperatures. The period of application is probably dependent upon the commencement of feeding by the larvae and from this year's studies all the borers were not feeding until June 7. However, this point is only supposition, because it is possible that the larvae might be susceptible to the poison while they are in their over-wintering condition of dormancy. Unfortunately, no data were obtained on this very important point.

Summary

1. None of the earlier recognized remedies was rapid and effective in controlling the round-headed apple tree borer.

2. Calcium cyanide killed *Saperda candida* larvae without injury to the trees in 1926 and 1927.

3. It took two and one-half times as long to "worm" out young borers and over nine times as long to dig out old borers as to treat them with calcium cyanide.

4. Calcium cyanide does not become very active against the larvae until about the sixth hour after it has been applied and apparently its action ceases after 24 hours.

5. In order to secure the best results against old borers the poison should be covered with dirt.

6. A bellows duster does not put out a sufficient bulk of poison to be effective.

7. Calcium cyanide mixed with castor oil into a paste gave the most satisfactory control against young borers.

8. Shellac painted over the burrows of young borers gave almost negative results.

9. Potassium cyanide at the rate of one-half ounce per tree killed the trees.

10. Probably the best time to apply calcium cyanide is between June 1 and 15.

11. From one application of one teaspoonful of calcium cyanide, covered liberally with dirt, nearly all the old borers were killed.

12. Calcium cyanide is cheap and may be applied rapidly with positive results. In comparison with other remedies, our conclusions favor it over any other method experimented with at this laboratory. The costs for material and labor do not amount to more than one cent per tree on the average.

13. The round-headed apple tree borer is spread over a very wide area in North America and is especially destructive in Quebec, where it is a major pest of apple.

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SELF-CLEANING THRESHER FOR SINGLE PLANTS.

J. B. Harrington

(Received for publication March 19, 1928)

The need of a suitable machine for threshing and cleaning the seed of single plants rapidly without danger of mixture occurring has prompted different people to devise and make small threshers that would answer this purpose. For years the Cornell Plant Breeding Department have used a small machine that threshes single plants in rapid succession without carrying over a seed of one to mix with the seed of the next plant. This type of thresher has found rather wide usage at experiment stations. Perhaps the greatest objection to it is that the chaff must be removed from the seed after it has been emptied from the drawer of the machine. This is laborious to do by hand or with an electric fan and mixing may occur if it is accomplished with a fanning mill.

In 1924 Mackie and Hoffman *(2)* published a description of a machine devised for threshing rod rows of cereal crops. This thresher had the fan and cylinder mounted on the same shaft and the chaff and straw were removed from the grain during the threshing by means of a wind blast, there being no screens used.

The success of this nursery thresher gave the writer the idea of making a simple single plant thresher for grain on essentially the same principle. In the fall of 1924 he made a machine by modifying a Cornell single plant thresher and providing an air blast and an exit for the chaff. Much difficulty was experienced in making the machine thoroughly thresh and clean the grain without allowing a seed of one plant to remain to contaminate

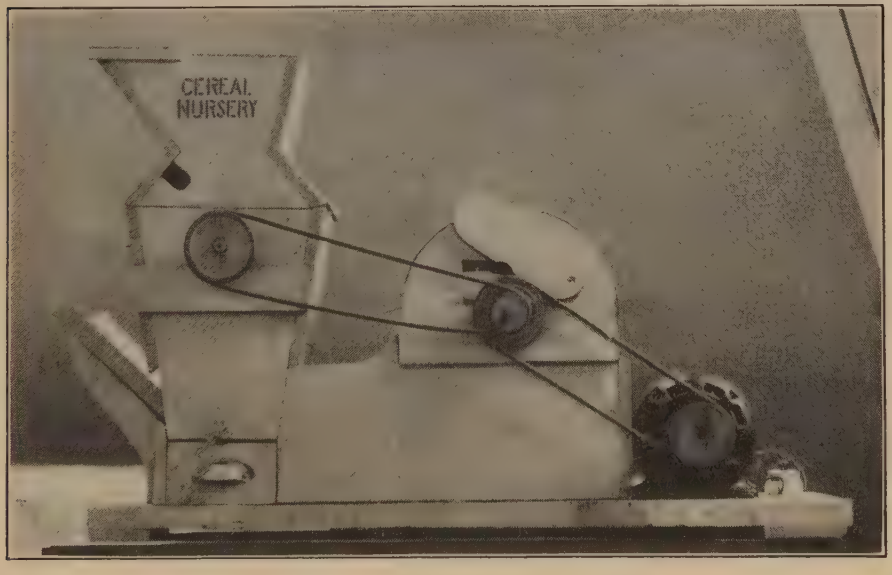

Figure 1. Side view of plant thresher.

*Paper read at the annual meeting of the Western Canadian Society of Agronomy, Winnipeg, Man., December, 1927.

the seed of any plants to be threshed later. In March 1925 this thresher was destroyed in a fire before plans of it had been made.

Hoffman *(1)* in 1925 produced a very simple ingenious single head thresher for grain. Except for its limited capacity this machine appeared to be an excellent device.

In 1927 Whitcombe *(3)* explained how to build a small thresher that would handle small quantities of material for the plant breeder or the cereal chemist. This thresher, like the Cornell machine, only threshed the plants, the cleaning having to be done separately.

In the fall of 1925 the writer* made from memory a thresher similar to the one lost in the fire in 1925. This proved even more satisfactory than its predecessor and in hundreds of trials was found to be quite reliable. It has now been used extensively for three years for threshing thousands of single plants as well as hybrid lines grown in five foot rows. It has also been borrowed a number of times by plant pathologists and by cereal chemists for threshing fairly large quantities of wheat heads where the straw had been removed fairly close to the heads. It threshes wheat, oats, barley, rye and flax satisfactorily. In 1926 the forage crop investigators discovered that it would thresh western rye grass, brome grass and alfalfa without difficulty.

The present report on the single plant thresher is the result of requests for a description and for plans of the machine. The machine as shown in Figures 1 to 3 is not difficult to construct and should not cost more than about fifty dollars outside of the one-quarter horse power electric motor that furnishes the power. In making this thresher the chief difficulty will

*The writer desires to thank Mr. J. Whitehouse of the Field Husbandry Department for drawing up preliminary plans of the thresher, Mr. G. Orr of the Agricultural Engineering Department for his assistance in planning the machine and seeing that it was properly constructed, and Mr. B. Templin, Agricultural Engineering student for drafting the plans.

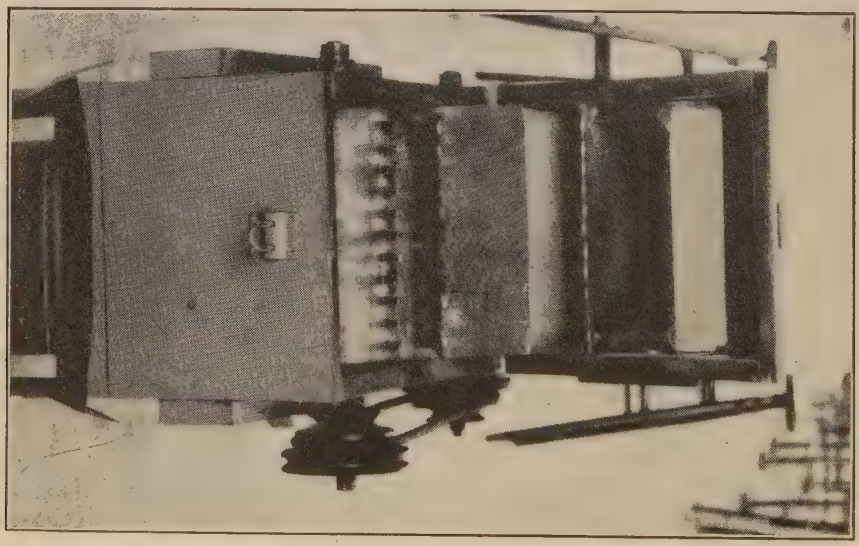

FIGURE 2. View of thresher from the end with the hopper portion thrown back on its hinges to show cylinder, concave block and inside construction of hopper.

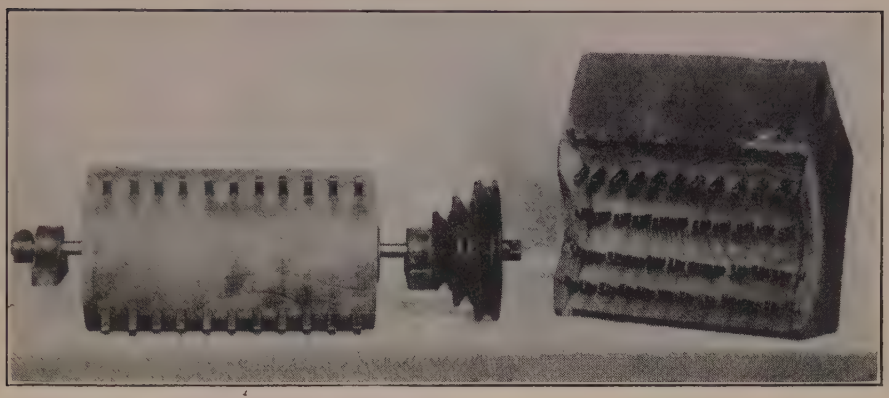

FIGURE 3. At left, cylinder with its shaft; at right, concave.

be found to be in the adjustment of the baffle plates and the wind blast. It is suggested that the baffle plates should only be tacked in lightly until by actual tests the proper angles and curvatures suitable for the best work are ascertained. To insure that no kernel or portion of the inflorescence remains in the machine, instead of passing into the grain drawer or out the chaff outlet, careful workmanship is of the utmost importance. There must be no rough edges or any sort of lodging places for grain within the machine. The air blast must be sufficient to remove immediately any kernel that bounces on to the tin floor of the air passage leading from the fan to the threshing chamber. If the air blast is too strong it may carry kernels over the metal inclined outlet for the straw and chaff. Several hundred plants of different grain crops should be run through a new machine consecutively before the baffle plates are tacked into their final position. Such a test will reveal any mixing and corrective adjustment can then be made.

A blue print and specifications of the thresher plans will be furnished by the Field Husbandry Department to any experimentalist upon request.

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SASKATOON, SASKATCHEWAN.

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SOIL MOISTURE STUDIES UNDER DRY-FARMING CONDITIONS*

S. Barnes

(Received for publication February 2, 1928)

The term "dry-farming" is applied to the cultural practices in those sections where crop yields are limited by the amount of available moisture. A study of soil moisture under such conditions is, therefore, of particular interest in order to determine what practices are the most efficient in conserving the moisture and what are the most profitable for its utilization.

The data presented in this paper have been collected, for the most part, at the Dominion Experimental Station, Swift Current, Saskatchewan. This station is located in the southwestern portion of the province, in a typical dry-farming area where wheat forms the principal crop. The soil at the station consists of a brown clay loam underlaid with a brownish gray clay.

Over a period of forty years the mean annual precipitation at Swift Current has been 15.2 inches and 8.0 inches during the crop season from April to July inclusive. The rainfall distribution is, on the average, favourable to the growth of spring seeded crops as the greatest amounts come at a time when these crops reach their period of maximum moisture requirement. There are, of course, wide variations from the mean rainfall distribution, the general effect of increased amounts being to increase the yields, providing the distribution has been favourable.

Methods Used in the Study of Soil Moisture

In view of the pronounced influence of moisture upon the growth of crops in dry-farming sections, an attempt has been made to determine the effect which crop rotations and cultural operations have on the loss or storage of moisture in the soil. Two methods are being used at Swift Current. In one case soil samples are taken in field plots at certain definite intervals, usually in the spring, summer and fall. The samples are taken to depths of 0 to 6 inches, 6 to 12 inches, and successive one-foot depths to a total of four feet. Sampling has been done with the soil auger and also the soil tube. If moisture conditions are satisfactory, the soil tube is preferred to the auger on account of the less labour required. These samples are then dried in the oven at a temperature of 100-105°C. for 24 hours and their moisture contents are determined. If the soil auger is used in securing the samples, duplicate 50-gram portions are used for the determinations. Where the tube is used, the whole core is dried. The data thus obtained are used as a basis for estimating the changes of water occurring in the plot. It has been the custom to sample each plot at two points about fifteen feet from the ends and to make a composite of each depth for moisture determination. The plots sampled in this manner include those in an experiment on different methods for the preparation of wheat stubble for a second crop of wheat, the influence of the time of plough-

*Paper read at the annual meeting of the Western Canadian Society of Agronomy, Winnipeg, Man., December, 1927.

ing the summer fallow, and the various substitutes for the summer fallow. The sampling of similarly treated plots is also undertaken by five of the other Prairie stations, namely Brandon in Manitoba, Indian Head and Scott in Saskatchewan, Lethbridge and Lacombe in Alberta.

The second method of study has been by measuring the moisture changes, through variations in weight, of the mass of soil contained in deep tanks. This work is conducted at Swift Current only. In these experiments a number of rotations is included as well as a duplication of the field experiments. Particulars regarding these tanks need not be given here as a full description appears in the Proceedings of the Third Annual Meeting of this Society.

Results of Moisture Determinations from Field Samples

The data from the field investigations appear to be subject to the same degree of variability found in crop yields and soils. In these studies it has been possible to trace the changes in soil moisture as determined by field samples in a general way only. To judge from the data accumulated there appears to be but little agreement between the amount of water lost from the soil and the corresponding yield of grain, in spite of the fact that comparatively small quantities of soil water exert a marked influence on crop yields. This is true of the data from all the co-operating stations. An attempt was therefore made to determine the limits of error attaching to soil samples as taken from field plots and used for moisture determinations. A number of borings were made on level summer fallow land at comparatively close intervals. This investigation was made on the station soil, which has been under cultivation for five years and also on rented land, about two and a half miles away, which has been cultivated for over twenty years. Some samples were taken by the soil auger and others by the soil tube, moisture determinations being made by the method already outlined. The following table shows the results secured by sampling at twenty points each eighteen inches apart:

Moisture Content of Soil—20 Borings

Depth of Sampling	Per cent Moisture		
	Highest	Lowest	Mean
0—6"	18.5	13.0	15.06
6—12"	16.8	13.6	15.29
12—24"	17.8	14.3	15.51
24—36"	18.2	15.0	16.80
36—48"	17.5	12.2	15.20

At another point on the station, where the surface and subsoils appear to be very uniform in texture, thirty-four cores were taken by means of the soil tube to a depth of four feet at points eighteen inches apart and the whole cores used in the determination of moisture. The results in this case varied from 20.5 per cent to 15.1 per cent with a mean of 18.7 per cent. Assuming the weight of a cubic foot of dry soil to be 100 pounds, the variations shown correspond to a difference of 4.15 inches of water in the four-foot depth of soil. As twenty, or even thirty-four, samples were too few

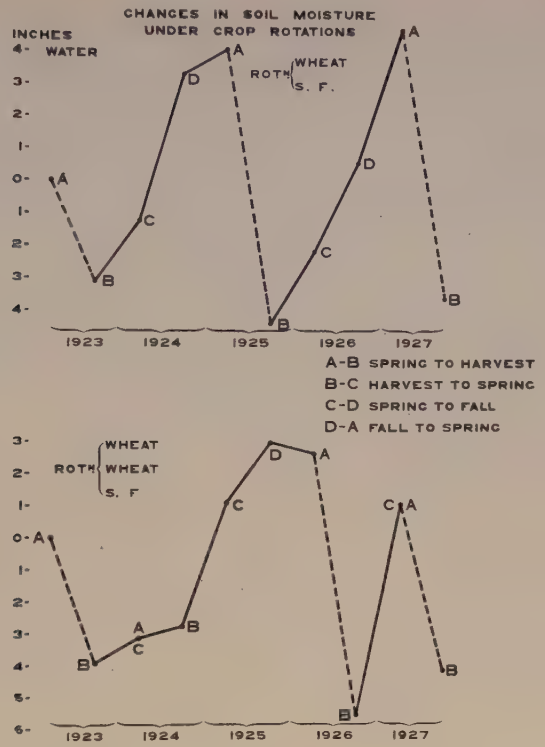
to determine the limits of error by the method of least squares, another series of 100 samples was taken. In this case both the station soil and the rented land were sampled. Because of the labour involved, however, the samples were taken to a depth of twelve inches only and at points twelve inches apart. In one case the results varied from 10.4 per cent to 17.6 per cent and in the other from 12.3 per cent to 19.1 per cent. In a twelve-inch depth of soil these variations are equivalent to 1.36 inches and 1.31 inches of water respectively. From the results of these determinations it is apparent that wide variations are present in the moisture content of the soil even in closely adjoining areas. As it is not practicable to sample the plots in a large number of places, on account of the labour involved and the unavoidable damage to the growing crop, the use of soil samples has not given results accurate enough to correlate crop yields with soil moisture variations.

Experimental Results with the Use of Deep Tanks

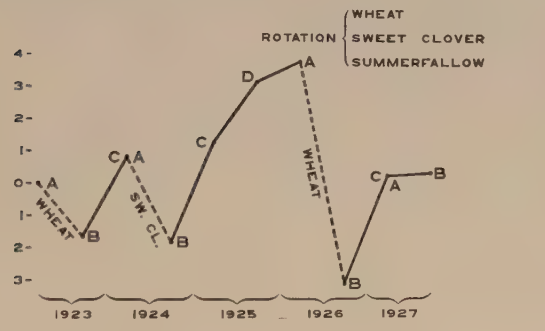
In the experiments with deep tanks filled with soil comparatively slight variations in soil moisture are readily detected through changes in weight of the soil. The wide variations in moisture found in the case of soil samples taken from field plots have been reduced considerably by the use of tanks. These tanks are filled with the surface and subsoil as in the field, are seeded to a crop and are surrounded with conditions approaching those in the field as closely as possible. Moisture for crop growth is derived entirely from the natural precipitation.

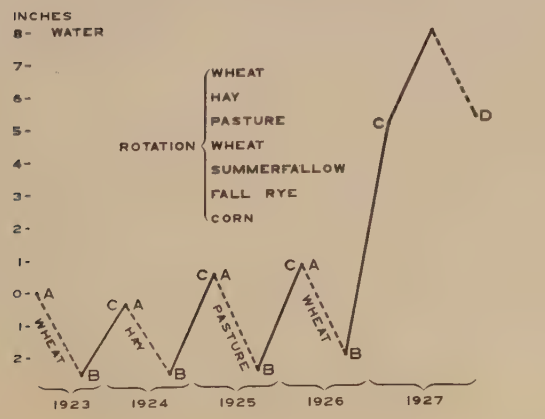
The use of tanks for the purpose of studying soil moisture is open to criticism on the ground that the original structure of the soil has been destroyed and that the plants grown in such soil are subject, in some degree, to abnormal environmental conditions for proper growth. Furthermore, the tanks, being limited in depth and watertight, do not permit the percolation of water beyond the depth of the tank nor the rise of capillary water from the deep subsoil. With the amount of precipitation ordinarily received at Swift Current the possibility of water ever percolating below the five-foot zone of soil, which is the depth of these tanks, is very remote. At no time since the investigations were started has the field soil been thoroughly moistened to more than two or three feet below the surface. The rise of capillary moisture is a negligible factor as free water does not exist within 150 feet of the surface. There is the factor of moisture transfer from the deep subsoil by distillation which has been investigated in Russia. Whether this action takes place here is not yet known and its effects cannot be determined by comparison of the growing crops. It is difficult to estimate what adverse conditions have been introduced by the destruction of the soil structure in the process of filling the tanks. The behaviour of the crops during their growth in the tanks, when compared with those in the field, warrants the assumption that any adverse conditions introduced by this method are insignificant in their effects in comparison to the variations caused by differences in available soil moisture.

The results of these experiments bring out very clearly the intimate relationship between crop yields and moisture supply. This relationship is illustrated by the accompanying charts, which show the increase and de-


CHANGES IN SOIL MOISTURE
UNDER CROP ROTATIONS
INCHES
WATER
ROTH
WHEAT
S. F.
1923
1924
1925
1926
1927
A-B SPRING TO HARVEST
B-C HARVEST TO SPRING
C-D SPRING TO FALL
D-A FALL TO SPRING

ROTH
WHEAT
WHEAT
S. F
1923
1924
1925
1926
1927


ROTATION
WHEAT
SWEET CLOVER
SUMMERFALLOW
WHEAT
SW. CL.
WHEAT
1923
1924
1925
1926
1927


INCHES
WATER
ROTATION
WHEAT
HAY
PASTURE
WHEAT
SUMMERFALLOW
FALL RYE
CORN
WHEAT
HAY
PASTURE
WHEAT
1923
1924
1925
1926
1927

crease in the moisture of the soil under four crop rotations. In all, nine rotations are included in the experiments, but the examples shown are representative of the group. The rotations are:

Two years	Wheat, summer fallow.
Three years	Wheat, wheat, summer fallow.
Three years	Wheat, sweet clover, summer fallow.
Seven years	Wheat (seeded to brome grass) hay, pasture, wheat, summer fallow, fall rye, corn.

The experiments have not been carried on long enough to include every year of the seven-year rotation so that the first five years only are shown on the chart. Each chart is divided into periods representing spring to harvest, where the soil is cropped, and harvest to spring. The loss of moisture due to transpiration by the growing crop is indicated by a dotted sloping line, and the subsequent gain due to the fall rains and winter precipitation is shown by the full black line for the period harvest to spring. In 1924 the second wheat crop, of the rotation wheat, wheat, summerfallow, was so poor that the soil actually gained in moisture between the period of spring and harvest. The same is true of the 1927 crop of sweet clover in the wheat, sweet clover, summer fallow rotation except that the cause was due to a partial winter-killing of the sweet clover rather than a deficiency in moisture. The summer fallow period is shown as extending from the time of harvesting the crop before the summer fallow until the next is seeded. This period is divided to show the soil moisture increases during the time from harvest to spring, spring to fall, and fall to spring. In every case the losses or gains shown on the charts represent moisture changes as determined by the differences between the initial and final weights of the tanks for the periods stated.

The diagrams bring out several fundamental facts concerning dry-farming practices. The value of the summer fallow, proved by years of practical experience, is clearly demonstrated. The summer fallow furnishes not only a reserve of soil moisture but it permits a more efficient utilization of the total supply. In every case the crop following a summer fallow has been able to use more of the soil moisture than where it directly followed a previous crop.

The early ploughing of the summer fallow is considered essential to success. The time of ploughing is possibly not of such importance as the effectiveness in controlling weed growth. It will be seen on the charts that, in some seasons with abnormal fall or early spring rains, the summer fallow will store more moisture than during the period after it is ploughed. If ploughing is delayed and weeds are permitted to grow, the reserve accumulated during the fall and winter months is quickly dissipated.

What is true of the summer fallow and weeds applies also to the so-called substitutes for the summer fallow. Under the climatic conditions of Swift Current the practice of using various intertilled crops merely exposes dry farming to the risks incident to continuous cropping. In seasons of abnormally high precipitation profitable yields are secured, but such seasons are the exception rather than the rule.

There is frequently considerable comment on the hesitation of farmers in dry-farming sections to adopt a systematic rotation which includes diversified crops. Wheat is at present by far the most important crop while grass and clover crops by comparison are insignificant in amount. One reason for this is not difficult to find; it is undoubtedly due to the fact that the limited moisture supply and its distribution are favourable to the more profitable grain crops. At Swift Current a profitable crop of grass is secured in seasons of abnormally high rainfall only. Aside from that, however, for every ton of hay produced a considerably larger quantity of fodder can be secured in the form of oat green feed. Legumes have the power of taking nitrogen from the air and, if the crop is ploughed under, ultimately enriching the soil's supply of nitrogen. It is reasonable to expect that the extra soil fertility would increase the yield of wheat from such land, but the reverse is more often the case. Wheat yields from clover land are generally lower than those on summer fallow land. This condition is not peculiar to one locality but it is the general experience where dry-farming is practiced. Similar results have been obtained when the comparison was between wheat on grass sod land and wheat on summer fallow. The time of ploughing the sod appears to have a profound influence on the results. If the sod is ploughed very early the difference in the two yields becomes less, that is to say, the sod land approximates the moisture conditions of the summer fallow. Late ploughing permits the grass to exhaust the available soil moisture and any benefits resulting from the addition to the soil of organic matter and vegetable fibre are masked by the deficient moisture conditions.

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THE TECHNIQUE OF PRODUCING ELITE STOCKS OF NORMALLY SELF FERTILIZED GRAIN CROPS*.

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With the great increase in the number of cereal varieties the problem of producing satisfactory stock of Elite seed becomes increasingly perplexing. It becomes obvious that modifications of the method employed for the producing of such stocks must be introduced from time to time in order to cope with the increasing tendency for the varieties to become mixed.

Elite Stock seed in Canada is defined as seed which is 99.995 per cent pure as to variety. Obviously, then, we may ask what is a variety? When is a variety 99.995 per cent pure? How can such a condition be obtained and can it be maintained? Is this standard of purity ever attained considering the genetic complexities of certain commonly grown agricultural varieties of cereal crops? These are pertinent points of interest to the grower, but it is not the intention of this paper to deal with them in detail. It is, however, realized that sooner or later it will be necessary to deal with each on its merits.

Three general methods of procedure for the production of Elite stocks of seeds from normally self fertilized crops are at present recognized. They are as follows:

(a) Mass selection of heads, spikes or panicles.
(b) Individual plant selection (sometimes erroneously called pure line selection.)
(c) Mass selection with the plant as the unit of selection.

Assuming that we are agreed on what constitutes a variety of given name, we may then proceed to discuss the merits of the three methods outlined above. If we cannot agree on the constitution of a given variety, then the discussion of any method of producing Elite Stocks of a given purity is of no purpose.

Mass Selection of Heads or Panicles

Mass selection of heads as a procedure in the development of Elite Stocks of seed is the most primitive of the three methods. Many consider it obsolete when dealing with normally self fertilized plants.

Considered on the basis of producing progenies of exact uniformity, it is the least effective of the methods in vogue. By mass selection of heads it is, at best, only possible to eliminate the most obvious mixtures commonly occurring in commercial varieties of cereals. Whatever its shortcomings, it has been used to good advantage in the past. Probably its most outstanding claim to consideration lies in the fact that it retains, in a large measure, the numerous biotypes entering into the genetic complex of many commercial varieties. Some argue that the general use of this method acts as a restraint to the enthusiasm of varietal fanciers and fadists. Whether it does or not

*Paper read at the annual meeting of the Western Canadian Society of Agronomy, Winnipeg, Man., December, 1927.

is beside the question. If such is its place, it is probable that in such a capacity it may prove to be highly commendable.

However, I am inclined to agree with those who would eliminate the method as a means of developing Elite Stocks of cereal grains or other crops which are normally self fertilized.

Individual Plant Selection

Single plant selection, or the production of Elite Stocks of seed arising from a single plant progeny is the antithesis of mass selection of heads. In the hands of the trained grower or plant breeder this method has marked possibilities in the matter of improving crops. Yet its desirable possibilities may become a menace to the establishing of limits of variability for a given variety where differences of opinion exist as to the type of such a variety.

As a method of producing Elite Stocks of seed it is becoming rather widely used by both growers and plant breeders, with the net result that with the lapse of time Variety "X" in Manitoba is not Variety "X" in some other province. In fact this method may be said to be on the way to becoming the popular fad of the day.

The method has of course many admirable advantages, provided effective control measures can be developed to prevent hair-splitting differences of opinion as to the merits of the various biotypes isolated from any given variety. That such a condition should exist is, to say the least, deplorable.

Where biotypes measurably different from the parent strain are isolated and propogated, the only logical procedure is to treat such as new varieties, regardless of geographical position.

Geographical position may bring about certain differences with regard to yield, maturity, stature, and even quality of the crop resulting from a given variety. It does not, however, account for the appearance of well recognized inheritable characters of morphology differing widely from those of the parent strain. It is in just such instances that the great weakness of the method becomes manifest.

There is no question that by the selection of single plant lines, especially those exhibiting a very high degree of uniformity, very consistent strains may be obtained. However, if the strain deviates markedly from the recognized standard of type, we are introducing greater instead of less variability in so far as the variety is concerned, unless such deviations are treated as new productions. There is only one obvious solution, i.e. the development of standards for all prospective varieties about to be considered eligible for registration, before such varieties are recognized as registrable. Further, the establishing of a referee plant breeding station would be a step in the direction of controlling marked deviations. The establishing of such a station would tend to eliminate the controversies between growers and breeders regarding the merits of certain strains.

Is the extreme degree of uniformity of a given variety the most desirable factor to be obtained? May not a little fastidiousness and overenthusiasm play a large part in the assumed advantages to be obtained by

growers from the single plant selection as a means of producing Elite Stocks of seed?

In the face of varying seasonal conditions one cannot see the advantages to be gained by the use of commercial varieties of genetic purity approaching that of a "pure line". This is especially so when the standards of purity are often established entirely on the basis of minute and minor morphological characteristics. Single plant selection on a wide scale threatens to create confusion when dealing with old long-established varieties for which no recognized descriptions exist unless certain control measures are established for the purpose of checking on such material. Consequently it would appear that this method could best be applied to those varieties for which there is available a well developed description of type.

Mass Selection with the Individual Plant as the Unit of Selection

Mass selection with the individual plant as the unit of selection is considered by some as a compromise between "mass selection of heads" and "individual plant selection". Whatever its handicaps, the method has certain advantages in the hands of the grower not to be found in either of the other procedures, as a means of producing Elite Stocks of seed. It has the advantage over "mass selection of heads" in that close observation of single plant progenies in the early stages of the procedure allows for some choice in the matter of variability, which is to be allowed in the ultimate seed stock. The ultimate massing or blending of forty or more of these selected plant lines permits of the retention of a greater number of the biotypes common to the variety in question. Further it permits of the rapid elimination of obvious admixtures which, after all, is the intent of any method designed for the purpose of retaining the general characteristics of a variety. In other words, it is more rigid and effective than "mass selection of heads" but more elastic and less severe than "individual plant selection".

The method has been used for some time in Manitoba by farmer growers wishing to produce their own Elite Stocks of seed. The technique may vary slightly with the grower but in general it is simple, rapid, and effective in dealing with those varieties for which we have no recognized official description and, until such time as more clearly descriptive guides are provided, the method has a place in the developing of Elite Stocks of seeds.

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ELEMENTAL SULPHUR AND PHOSPHATE SALT MIXTURES AS FERTILIZER*

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In field and greenhouse work conducted at the University of Maryland Agricultural Experiment Station at College Park during the years 1923 to 1926 it was observed that the application of elemental sulphur-acid phosphate fertilizer mixtures to the experimental soils used decreased the yield of most of the crops worked with below the yield obtained with acid phosphate alone.

In our work acid phosphate by itself almost invariably increased yields over untreated checks, sulphur by itself affected yields very slightly either way, but mixtures of acid phosphate and sulphur almost always lowered yields greatly below those obtained with acid phosphate by itself. Pulverized raw rock phosphate by itself, when applied in quantities equivalent to the acid phosphate applications used, did not increase yields nearly as much as the latter. But when elemental sulphur was mixed with the pulverized raw rock phosphate yields were obtained nearly equal to those obtained with the acid phosphate by itself. Thus, the effect of sulphur on crop yields when used with raw rock phosphate is exactly the reverse of its effect on yields when used with acid phosphate mixtures. This work is reported in Bulletin No. 296 of the University of Maryland Agricultural Experiment Station.

To find out how sulphur behaves in mixtures with other phosphate salts, as well as calcium monophosphate, work was carried on in pot cultures in the greenhouse during the winter of 1926-27.

Sassafras loam soil was air-dried and screened through 1/8th inch mesh screen. Red clay tile pots 10 inches high and 10 inches in top diameter were paraffined to prevent absorption of salts, and 8300 grams of the screened soil was placed in each. The lime requirement, by Veitch method, of the soil used was 3000 lbs. of $CaCO_3$ per acre. Calcium carbonate was mixed with the whole 8300 grams of soil at the rate of 12.3 grams per pot. All of this calcium carbonate, which was chemically pure material, would pass a 100 mesh screen. To ensure fairly uniform moisture conditions throughout, a one-inch column of washed glass sand was placed in the centre of the soil in each pot extending from top to bottom.

On February 19th four uniformly developed 7-days old Marquis wheat seedlings were placed in each pot. Distilled water was used to water these plants throughout the experiment and the pots were moved about on the greenhouse bench to ensure uniform lighting and temperature conditions for all.

On February 19th, prior to putting the seedlings in the pots, the fertilizer and sulphur applications were made. The treatments are given in Table 1 together with the resultant yields from each pot. The lime was

* Published by permission of the Director, University of Maryland Agricultural Experiment Station.

mixed with all the soil in the pots on February 12th, one week previous to planting the seedlings, while the fertilizer and sulphur applications were mixed with the top 3 inches of soil in the pots on the day of planting.

Each treatment was made in triplicate, 12 treatments making 36 pots in all. The phosphate salts used were chemically pure $Ca_3(PO_4)_2$, $Ca(H_2PO_4)_2.H_2O$, KH_2PO_4 and $(NH_4)_2HPO_4$, each salt by itself in one treatment and intimately mixed with elemental sulphur in another. $Ca(H_2PO_4)_2.H_2O$ was also used in a mixture with $(NH_4)_2SO_4$ and KCl, with and without sulphur. "No treatment" pots and "sulphur only" pots were included in the treatments studied.

The rate of application, where sulphur was added to the pots, was in all cases equivalent to 100 pounds per acre, assuming the weight of an acre of surface soil to be 2,000,000 pounds.

The wheat was harvested when mature, on May 28th, 1927, and oven-dried at 100C°. It made excellent growth throughout the experiment although aphid infestation had to be removed several times by fumigation with "Nicofume." The "Nicofume" fumigation proved very effective in this respect.

TABLE 1.

Pots.	Treatment per pot:— 8300 grams of screened soil used. Fertilizer treatments mixed with surface 3 inches of soil.	YIELDS OF MARQUIS WHEAT	
		Average yield, grams grain (Oven-dry), and Probable Error$_m$ (Bessel's formula)	Average yield, grams grain and straw (Oven-dry), and Probable Error$_m$ (Bessel's formula)
1 to 3	2.06 grams $Ca_3(PO_4)_2$	8.776±1.47	22.898±3.70
4 to 6	2.06 grams $Ca_3(PO_4)_2$ plus 0.41 " elemental sulphur	10.646±1.78	33.940±3.44
7 to 9	2.06 grams $Ca(H_2PO_4)_2.H_2O$	10.578±0.68	29.880±1.55
10 to 12	2.06 grams $Ca(H_2PO_4)_2.H_2O$ plus 0.41 " elemental sulphur	6.967±0.87	20.680±2.33
13 to 15	0.82 grams $(NH_4)_2HPO_4$	15.320±1.27	44.340±3.36
16 to 18	0.82 grams $(NH_4)_2HPO_4$ plus 0.41 " elemental sulphur	12.768±0.69	37.260±0.91
19 to 21	0.82 grams KH_2PO_4	11.319±0.76	36.940±0.99
22 to 24	0.82 grams KH_2PO_4 plus 0.41 " elemental sulphur	10.675±0.53	29.610±1.29
25 to 27	1.23 grams of mixture (0.27 gms. $(NH_4)_2SO_4$; 0.82 gms. $Ca(H_2PO_4)_2.H_2O$; 0.14 gms. KCl)	11.616±0.61	32.630±2.11
28 to 30	1.23 grams of mixture as above plus 0.41 grams elemental sulphur	6.428±0.27	19.860±0.61
31 to 33	0.41 grams elemental sulphur	6.820±0.49	24.540±1.94
34 to 36	No treatment	8.662±0.13	27.160±0.58

The results of the experiment are given in Table 1. The average weight per pot, from each treatment, of the grain only is recorded in one column and that of the grain and straw in another. It will be seen that the differ-

ences in yield are not significant between phosphate salt only and phosphate salt plus sulphur except in the case of the $Ca(H_2PO_4)_2.H_2O$. With the calcium monophosphate, both alone and in a mixture with ammonium sulphate and potassium chloride, there is a very decided decrease in yield due to the addition of sulphur.

With the tricalcic phosphate, $Ca_3(PO_4)_2$, although the yields are greater where sulphur was added, the experimental error is so large as to render conclusions unwarranted from this trial. With all the treatments except $Ca_3(PO_4)_2$ the average yield of wheat from the cultures has been decreased by the addition of sulphur.

Summary.

This work confirms our previous findings as to the toxicity of acid phosphate-sulphur mixtures towards certain farm crops when applied to Coastal Plain soils. With other soluble phosphate salts the toxic effect of sulphur admixture obtains, though not to the same degree as with the calcium monophosphate $Ca(H_2PO_4)_2.H_2O$.

The theory as to the cause of the observed toxicity of elemental sulphur-acid phosphate mixtures is that the soluble phosphate salt strongly buffers locally the acidity produced by oxidation of the sulphur particles. The consequent long-maintained intense acidity in "pockets" is injurious to plant root tissue. See Bulletin No. 296 of the Maryland Agricultural Experiment Station for a more extensive discussion of this theory.

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RESEARCH IN AGRICULTURE*

W. H. Brittain

A discussion of the specific problems demanding investigation in agriculture today, of the methods whereby they should be attacked and of the trends that may be discerned in this field at the present time, is a subject upon which even an individual with a firm and established reputation in the realm of research might well hesitate to embark. Let me say, however, that I do not propose to deal with this aspect of the question, but rather to trace briefly some aspects of the historical development of our institutions of training and to touch upon a few of the more elementary problems of organization for research with which we are confronted today.

The question of research is inseparable from that of the training of the research worker and this is supposed to be the function of the faculties of agriculture of our universities and of our agricultural colleges—not that the agricultural curriculum can be based upon the needs of research workers alone, as this class will always remain a small proportion of the total number receiving training, but for the present we must confine ourselves to this aspect of the question.

It will be generally admitted by those who have carefully considered the question, that the chief concern of the agricultural college should be to discover and develop that rare individual the creative research worker, since it is to him that we must look for the discovery of new principles and basic ideas. We need also to secure the individual, not necessarily of more than average ability, but fitted by temperament, character and interest for elaborating and developing ideas and principles already discovered; he must be enabled to secure a sound training in general science, before being encouraged to proceed with more specific studies. Finally he should be led to grasp the important fact that the living organisms, with which he has to deal, do not recognize the artificial subdivisions of science reflected in our examination system and, too often, in our departmental organization. He should learn among other things that he cannot go very far in animal or field husbandry or horticulture without getting into the chemistry of plant and animal nutrition, that he cannot go very far in plant pathology or entomology without encountering problems of a chemical or physical nature, and that no experimentation of any kind can be engaged in without involving mathematics. All, I think, will agree that our research specialists require, above everything else, training in the methods of research. It goes without saying that, to be of any use to agriculture, such specialists should understand the problems of agriculture, but added to that must be the natural aptitude for this type of work, reinforced by a grounding in the basic sciences and supplemented by a mastery of the technique of the special science that is to engage his attention.

Our early efforts were undoubtedly crude and blundering enough. Those were the days of crowded time tables, with every moment of the

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student's day taken up in the laboratory and classroom. Yet the student was expected to prepare a "thesis" in his fourth year. They were the days of crowded curricula, with all students taking the same courses. It was not an uncommon thing in those days for the student to write twenty or more examinations at the end of a term. As new subjects developed they were simply added to the curriculum by reducing the time given to other subjects. The work was necessarily superficial. Science was kept very much "in its place" and some institutions rather boasted of the fact. As time went on, minor alterations were made and students were allowed to elect certain "options" in the fourth year in which to "specialize". When we reflect that this "specializing" meant the cutting down of the subjects taken from twenty or more to twelve or thereabouts, it will be seen that at least the criticism of too early specialization did not apply to this situation. The basic idea behind this sort of "training" was, first, that it was necessary for future farmers to learn something of everything that they could use in their work and, secondly, that such training should be "practical".

Some critics have said that our early agricultural colleges were little more than stock judging schools, and one might almost be pardoned for thinking so, considering the emphasis placed on such subjects and from the fact that much of the teaching was indeed dominated by the physchology of the show ring. It was but dimly realized, if at all, that the general agricultural practices of our rural population are the crystalization of the accumulated experience of ages, and are, in the main, sound. There was little appreciation of the fact that the greatest, most permanent and most rapid progress in agriculture would not come alone through making better stock judges, according to the then existing standards of stock judging, nor even in adopting new cultural methods, according to the standards of the agricultural teachers of that time. It was not realized, as it is today, that permanent progress in agriculture will come mainly through the application of the basic sciences, in the production of superior varieties, in the elimination of such inhibiting factors as plant diseases and in the more efficient organization of marketing facilities. The striking metamorphosis that is now in process whereby the animal husbandman, the field husbandman and the horticulturist is becoming, on the one hand, either a herdsman, a farm foreman or a gardener, or, on the other, a geneticist, biochemist, physiologist or pathologist, had not then begun. The situation to which we are slowly, but none the less surely and inevitably coming, when this metamorphosis will have become complete and when work in many of the so-called practical subjects will be relegated to secondary or vocational schools, or embodied in courses not of university grade, had not even been thought of. General courses will always be necessary, but specialized courses must be reduced to a minimum except for specialists in these subjects.

The growth of the agricultural colleges in Canada sychronized with the growth of departments of agriculture, and it soon became evident that an increasing proportion of graduates, instead of returning to the farm, as was expected of them, became absorbed by these expanding organizations.

These graduates in many cases, though by no means all, were men deficient in early academic training, and none of them could be said to have received more than a smattering of anything during their years at college, much less a training in the fundamental sciences that would equip them to oversee, initiate or direct research problems. Nevertheless, such was the demand, that many were soon holding positions calling for scientific attainment and technical knowledge. A time came, however, when this period of expansion ceased. The major positions were all filled with young men and there was not even the normal replacement that would occur in the old established organizations. One of the immediate effects of this, added to the partial realization that present staffs must be reinforced by junior men with some training in modern experimental methods, was the raising of qualifications for candidates for technical positions.

This had, in turn, its effect upon the agricultural colleges where the scarcity of available positions in technical agriculture automatically reduced the number of students applying for admission, a situation accentuated by the attempt to level up the standards of work to the grade of the other university faculties and thus meet the higher requirements of applicants for technical positions. I believe that this levelling up process has been more successfully accomplished in those cases in which the agricultural staff forms, in fact as well as in name, the faculty of a university. In all cases, however, an attempt was made to give science a larger place, while the time devoted to purely agricultural subjects was reduced. An effort has also been made to change the method of presentation of such subjects, in order to show their relationship to agriculture as a whole, rather than to give any specialized training until fundamentals have been mastered. The number of required subjects has been reduced, more electives offered and an earnest attempt made to fit the work more nearly to the needs of the individual student.

Some institutions, therefore, have been successful in reorganizing their courses in line with modern ideas, but in others the dead hand of the past still maintains its grip. Even where apparently radical changes have been made their results have been negatived by failure to understand underlying principles. In some cases the crowded nature of the curriculum still exists; every student during his first two years must take every subject from silo building to beekeeping; he still receives ready-made, predigested instruction, while the number of unit credits required for graduation is in some cases double that required by other faculties, or by the higher grade agricultural colleges in Canada or the United States. That individual institutions and instructors have, in some cases, but imperfectly assimilated these new ideas is clearly shown by the number of subdivisions into which the elementary courses in the "practical" subjects are still fragmented and by the fact that all the offered courses in such subjects have to be swallowed in a lump by all students alike. That even the scientific staffs at certain institutions have visioned the new ideas only "as through a glass darkly" is indicated by the fact that specialist scientific subjects such as entomology, bacteriology and plant pathology are still found occupying equal rank in the work for the first two years with such basic studies as

chemistry, physics, botany, etc. In some cases mathematics has even almost if not quite been ignored, in spite of the mathematical basis of our higher experimental work.

It is to be feared that even yet the terms " practical" and "scientific" subjects and "inside" and "outside" departments are still used with their original meaning at certain of our agricultural colleges. It is but imperfectly realized that for many phases of applied chemistry or biology, the laboratory is the field, the garden, the orchard or the farm animals, just as it is in the case of the so-called "outside" departments and too often when the parasitologist, the plant pathologist or physiologist requires animals or growing crops to work with, such facilities are dispensed with a niggardly, grudging and reluctant hand. It is to be feared that in some cases our work is still superficial, where it does not degenerate into futile dabbling, that there is still insufficient attention given to the important problem of developing the initiative and independence of the student, or of allowing him to obtain practice in the solution of even elementary problems. I have known agricultural graduates, naturally fair students, who left college without even having heard of the Experiment Station Record. There would appear to be as much opportunity of developing any constructive thought under such a system as in a penitentiary. It is small wonder that men looking for trained assistants, sometimes themselves agricultural college graduates, declare, as I have heard several do, that they would not have an agricultural college graduate at any price, preferring "Arts" men.

Thatcher, in a recent thoughtful article in the *Scientific Monthly,* referring to research agencies in the United States, writes, "Thus, these research agencies have had impressed upon them from the beginning the conception of the type of problem and the method of attack which comes from university training in sciences, a most fortunate experience, I think, because it is necessary to the proper application of research to agriculture and home making." Unfortunately, our own agencies have not always had such direction. Too often ability in handling labour or in judging cows has been considered of higher value than skill and training in the methods of research, and this attitude has been all too plainly reflected in our teaching.

There is another matter that calls for comment at this point. I have already referred to the falling off in attendance at our agricultural colleges. This gave, and is still giving, the leaders in such institutions grave concern. All sorts of schemes have been attempted in an effort to entice students within our walls. One method has been to offer special courses, not of university grade, designed especially for farmers' sons who plan to make a life work of farming. I need only refer to this development in passing as it is outside the question that we are now discussing. The other, however, is intimately connected with it. I refer to the movement to establish graduate work in agriculture at certain of our agricultural colleges and universities, and thus divert, at least partially, the flow of Canadian students across our borders. Though undertaken, in some cases, without any real appreciation of what was involved, the movement proved unexpectedly popular. Comparatively large numbers of students presented themselves for

this so-called advanced training and many, in due course, obtained degrees. The result was that the leaders of certain institutions, who at first held out against the tide on the ground that they already had a task sufficient for their powers and facilities, have been, in some cases, practically forced by the pressure of their staffs to follow the lead of others, much as the Israelites coerced Samuel into giving them a king like other nations. We cannot at this time go into the question of graduate study, or of how and by whom it should be taught, but it must be admitted that the results accomplished in some cases have had little effect, other than to feed the vanity of the professor in charge; the effort involved has had a particularly baleful influence, in that it has distracted attention from undergraduate studies, already so badly in need of revision, and from the undergraduate himself, who requires all the time and energy that the already overworked instructor can give him.

One of the strongest criticisms of our graduate schools on this continent is that too many students have registered for such work, not because they felt the urge for further training, not because they felt the need of the increased efficiency in their profession, but because, in the absence of employment, it seemed the best course to take and the one most likely to secure them a better position. As a result men of mediocre ability or less, and lacking in the true scientific spirit, have been encouraged to embark upon a career that only the outstanding student or the man especially fitted by temperament and inclination, should be encouraged to consider. I have not overlooked the fact that other than research workers might be benefitted by further training, nor do I wish to infer that good teachers or good extension workers are common or easy to procure. Agriculture, indeed, is such a broad subject, that there is even a better argument for extending the length of the course than there is in the case of the medical course. However, again we must confine ourselves to the needs of the research worker.

Here again, I do not mean to give the impression that the movement to establish graduate training at our Canadian institutions has been an unmitigated evil in all cases. On the contrary some institutions are undoubtedly doing work of a very high grade; students of character and ability are being turned out, who might otherwise have never received such training or, having received it elsewhere, been lost to the country. We must multiply this number if we are to grow and prosper. At the same time, I would favour an impartial survey of the entire situation, such as has been suggested that this organization should attempt. I think we will all agree that it is better to leave this work to a few institutions and only to those particular departments, where, by reason of personnel, equipment and inclination, a student can be assured of the best possible conditions to develop his powers under competent and inspiring leadership.

This brings me to the second division of my subject, viz., the organization of research. There are some who contend that research cannot be organized. They maintain that, immediately you attempt to organize it, you destroy its very spirit. They argue that its greatest enemy is the organizing expert who, turned loose with funds and a few assistants—the

fewer the assistants, the more the organization—proceeds to organize all the initiative and interest out of them. In other words, those who hold these views say that what is needed is *not so much organization as atmosphere,* not buildings and equipment so much as trained personnel under competent direction.

Without depreciating in any way the importance of organization, allow me to present two illustrations that have come under my own notice in order to present this point of view. A young man once took up work under a great English biologist, who only lately passed away. He spent, if I remember correctly, some two years of intensive, but interesting and fruitful labour under the direction of this great man. During all the time he was not asked for his attendance record, neither was he requested to present any monthly report, nor to prepare an estimate of the amount of money saved to the country through his efforts. At the end of the period referred to he desired to go with some friends to Switzerland for a short holiday. With some diffidence he approached his chief with this proposition, who, with an air of slight impatience at such a trivial question, informed him that it was quite unnecessary to make such a request, since he was quite at liberty to go to Switzerland or to Timbuctoo, if he could so arrange his work, provided he left a note behind him giving his address and probable date of return.

The other case was that of a young man employed by a government department. For the sake of illustration we will say that it was in Tokio. He was keenly interested in a certain line of investigation and, after having spent several of his evenings in making observations in connection with his work, arrived at the office one morning one half hour late and was duly docked a day's pay.

Which of these two young men, granted that they had, originally, equal interest and ability, would be most likely to show the greatest future keenness in his work and which institution would you consider was developing an atmosphere most conducive to producing the true research spirit? It may be pointed out that, to allow the freedom referred to in my first example, would completely disrupt any department that attempted it. Under the present conditions this would be true. Unfortunately, in the case of governmentally controlled institutions all our scientific staffs are diluted with a great army of clerical, administrative, and regulatory workers, and this is the greatest weakness inherent in any organization in which all these different functions are combined.

In spite of the foregoing, some organization is necessary to provide funds and facilities for carrying on any line of work and insuring its continuity. Without careful organization nothing worth while can be accomplished. There are two possible methods that have been adopted in different countries for the organization of research in problems relating to agriculture. In one we have the highly centralized, government endowed and controlled institution; in the other we have a decentralized system in which certain organizations, perhaps supported originally by private or semi-public bodies, have naturally grown up about certain problems, have

made a place for themselves and finally have come to be supported, in part, by State funds. Again, we have others that represent a compromise between the first two schemes.

Whichever of the foregoing plans we may favour we cannot deny the fact, proved by history and experience, that governments, whether local or central, have been at their best in administration, in the establishment and maintenance of standards and in similar work of a regulatory character. The criteria by which the success of officials conected with this work is judged are apt to be quite different from that of the research worker. He himself too often rates it in proportion to the size of the appropriation he can get passed by the committee, by the number of assistants whose appointment he can secure and by the number of letters that he dictates. His work is carried out under conditions and restraints that should be foreign to the life of a research worker. There are the interruptions of alien influences, the pressure for results, the restraints of a rigid budget system, the difficulties inherent in annual appropriations and the uncertainty of parliamentary action when an economy wave strikes the department, reducing expenditures on "non-essentials", among which research activities are sure to be classified. There are the restraints of the compartment system, into which all our government divisions are organized. Whoever today finds himself engaged in investigations connected with crops, or insects or farm animals soon finds his problems overstepping the limits of any one science, but we find the regulations, or the traditions of the service saying "Thus far shall thou go and no further". Of course, I am fully aware of the fact that men of good will in our government departments have, in many cases, risen above this natural tendency.

The work that the Division of Chemistry is doing in cooperation with the Entomological Branch, the work of the Rust Research Laboratory and others with which you are all familiar, are good examples. No one can deny, however, that our system makes this difficult to attain. That the foregoing statement presents a true picture, is proved by the fact that some of the most outstanding of the many splendid accomplishments of our departments of agriculture are in the realm of plant breeding or in other lines where close cooperation or coordination with the work of other departments is not an absolute essential of success, or in cases where the work is carried out in places remote from headquarters.

I do not for a moment believe that the average civil servant, at least in the departments of agriculture, deserves the cheap gibes that are so often thrown at him by those not in a position to know of his faithful and efficient work, often carried out under trying circumstances. I do believe that it would make a great improvement in the position of the research workers, in the character of the work performed, in the creation of that atmosphere to which I have referred and in the general morale of the service, if they could be removed bodily from their present association with activities quite alien from their true sphere of action, even if it should mean a complete reshuffling of departments, branches and divisions, which it does not.

The Commonwealth of Australia has attempted to solve its problem by placing all such work under a Council for Scientific and Industrial Research. It is not my desire, however, to outline any definite scheme, but rather to suggest the general idea. I do not believe that anything more is needed than a better working agreement between the different agencies at present existing.

There is undoubtedly a need for some controlling, coordinating and directing agency that can encourage, direct and even enforce proper team work among our different organizations, that will discourage duplication and competition—an agency qualified to make a survey of existing facilities and assist constructively those in need of assistance, to act as a clearing house for information, and to put the worker in touch with the problem. Recognizing the important fact that the problems of agriculture can only be solved where those problems occur and only by those in contact with such problems, this agency would assist in guiding research work into its natural channels.

There is, however, another aspect to the question. We in this country realize that we are overbuilt in railroads, that in other respects we are carrying an "overhead" more suited to a nation of 30 millions. Among other things we have too many agricultural colleges, none working to capacity, and connected with them in many cases, research organizations, starving for support. Is it not a tragedy that we should build more laboratories and embark on further large expenditures that we can ill afford? At the institutions referred to, at least the beginnings of important work have been made, under conditions that are favorable for investigations along certain lines and where the traditions and atmosphere conducive to the true research spirit are being developed; above all, where the men and women who must eventually recruit our expanding needs in this direction, are actually brought into contact with those who are actively engaged in studying these problems. Surely here is an unanswerable argument for decentralization! How otherwise are we to train this army of research workers, that we hear talked of so much, if during their years of training they do not make such contacts? There is a definite place for our experimental farms, our Provincial and Dominion Departments of Agriculture, our agricultural colleges and universities and there is no occasion for any competition between them. The work of each in naturally complementary to that of the others. They are cooperating more and more in the work of research, and the formation of committees on a federal and provincial basis, can eventually cut down all still existing inter-departmental and ex-departmental activities to a minimum. We do not, however, require any more organizations to enter the field at this time, to halt the trend toward better coordination that has already set in, to make confusions worse confounded, to cause further unnecessary duplication, to absorb funds badly needed for other purposes and to bring about a situation that can only end in irritation and disillusionment.

We cannot ignore the fact that we are suffering from the unguided way in which our agricultural research institutions have developed. It would be idle at this stage, however, to talk of starting all over again along

other lines; but it is perfectly legitimate, in fact it is incumbent upon us, to consider how we can so alter the structure of existing organizations that they can more efficiently serve the interests of applied research, that we strive to eliminate all unnecessary duplication, which we all know exists and that, with all means in our power, we resist the introduction of further such duplication. Let us remember that we all are to some extent the custodians of public funds, morally responsible for their most effective use; let us remember, too, that our activities are but the means to an end and that end, not the aggrandizement of any individual department, division or institution, but the improvement of the conditions of the agricultural classes of this country, and the strengthening of the basic fabric of the nation's premier industry.

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DAIRY BACTERIOLOGY IN SCANDINAVIA*

WILFRID SADLER

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Lately it was my privilege to enjoy extended leave of absence, for the purpose of working in England and on the Continent, thanks to the generous treatment of the University of British Columbia, and of the International Education Board (Rockefeller Foundation). The main object I had in seeking the opportunity to proceed abroad was to get such experience as would enable me the better to proceed with the work on the ripening of Kingston cheese, a research with which for a number of years I have been associated. I did some work in England, consulting with a number of those contributing to the advancement of dairying. Then I proceeded to Scandinavia, where for nearly eight months I worked with Professor Orla-Jensen in Copenhagen, and for three and a half months with Professor Barthel in Stockholm.

No discussion of Dairy Bacteriology in Scandinavia can be introduced without some reference to the earlier workers.

To the genius of Nils Fjord, whose life by Storch was published in 1891, may the beginning of dairy research in Denmark be traced. Fjord was born in 1825, and after his preliminary work in latin, matematics and certain of the sciences he became a student of the Royal Technical College (Den polytekniske Laerenstalt) in Copenhagen. An appointment as teacher in Physics in the Royal Veterinary and Agricultural College was offered to Fjord in due course. He interested himself in many activities, engaged in much investigation and, more and more, associated himself with inquiries into agricultural problems. In 1882-3 the research laboratory attached to the College was built. Fjord had created the opinion that made possible the building of these laboratories, and part of his dream was realized. As its first Director, not the least of his contributions was the appointment of Storch as head of the Chemistry Laboratory. The story of his life is almost an epic. "A very remarkable man", says Orla-Jensen.

Storch, discovered by Fjord, was still at fifty years of age a chemist in a commercial laboratory. His appointment to the Research Laboratory was opportune. Undoubtedly attracted by the work of Emil Hanson on yeasts, and the application of pure strains to brewing, Storch forthwith proceeded to investigate the possibility of utilizing pure bacterial strains in dairying. His first paper, Nogle Undersøgelser over Flødens Syrning, (Some Researches on Cream Souring), was published in 1890. This paper dealt with organisms isolated from good cream, included descriptions of the characteristics of these organisms, and presented some most excellent photomicrographs; these, according to Barthel, were the first photographs of bacteria from dairy products to be thus shown. Storch found many long chains. None of his original strains is now available, yet it is almost certain that his Culture No. 18 was identical with the strain that, later, Orla-Jensen isolated, studied and classified as *Streptococcus cremoris*. In Storch's work we have the fundamental studies which largely led to the application of

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starters in butter-making. Quite independently, Weigmann of Kiel had begun to explore the same field; and while Storch's publication came first, his studies, and those of Weigmann were proceeding almost simultaneously. As a result of his researches Storch became convinced that pure strains, that is cultures of single organisms, were not satisfactory for use as starters, a conclusion emphasized in his last important paper, published in 1919. Storch's great contribution was his study of the acid and flavour producing organisms of cream.

One must not forget the work of Professor C. O. Jensen, now Veterinary Director-General, and Director of the Animal Serum Institute of Denmark. In 1891 Jensen was working on dairy products, and issued a most interesting and valuable paper on "branket" or "malt-albumin" flavour in butter. This defect we now consider to be identical with the "caramel" aroma and flavour on which work has been done in later years in England, America and Canada, a defect caused by a *Streptococcus lactis* strain.

Although Freudenreich was not a Dane, he has played such a part in influencing that for which Denmark has since stood, that we must digress for a moment. Born in 1852, he died in 1906; lawyer, diplomat, and man of means, mountaineer, and friend of Miquel of Paris, he became interested in the bacterial content of the air at high altitudes. In 1884 he published his first paper on examinations he had made of the air. Almost at once, and fortunately for us, a study of the causes of the changes which constitute the ripening of cheese attracted him. In *Annales de Micrographie* he published, in 1899, his paper on "Preliminary Researches on the Rôle of Bacteria in the Ripening of Emmenthaler Cheese." He forsook law, and brought lustre to an infant science. He established the rôle of the lactic acid rod bacteria in the ripening of Emmenthaler cheese, and with his co-workers, subsequently in particular with Orla-Jensen, he continued, until his death, the researches which have laid the foundation for the work which is proceeding to-day on the ripening processes of hard-pressed cheese.

This very brief reference to Freudenreich and his work leads us naturally to Professor Orla-Jensen, his principal collaborator, his friend and biographer. This is not the place to refer to the work of the two at Berne. When the Professorship was created to attract Orla-Jensen back to his own country he had carried further the work of Freudenreich, and had produced evidence that the ripening of Emmenthaler cheese is due to enzymes of the lactic acid rod bacteria—more particularly the enzyme of *Thermobacterium helveticum* (Bacterium casei Σ). In the broad and fundamental sense, he remains to-day our authority on the ripening of hard-pressed cheese; and, for a clear and concise treatment of the whole question of cheese-ripening, his book "Dairy Bacteriology" should be consulted.

In his laboratories in Copenhagen, Orla-Jensen proceeded to study the lactic acid bacteria, with the avowed object of establishing a sound system for the classification of this significant group. The report of these studies, a monograph on "The Lactic Acid Bacteria," was published in 1919, and in English. The distinction with which he has pursued the course on which he had embarked is to be attributed to keenness of perception coupled with a rare degree of imagination, to an unusual persistence in application, a deep

knowledge of biological chemistry, a profound understanding of bacteriology, the intangible something which came from his association with Freudenreich, acquaintance with the technique of dairying, and last, but not least, the association with the work of his incomparable wife.

Whether or not the unique value of this work is either sufficiently known, or adequately appreciated by many of us is a question: the work recently characterized by Professor Weigmann as being the most distinct and valuable contribution in our field. It is not possible, here, even to attempt to do justice to the wealth within the covers of the printed monograph. In his introduction, Orla-Jensen comments upon the difficulty of understanding why various kinds of hard-pressed cheese, apparently containing the same microflora, should each have the taste and smell characteristic of the type. "There can hardly be any doubt", says he, "that these sorts of cheese in reality contain different species of bacteria, only we are unable to distinguish them by the methods hitherto employed. The object of the present work is primarily to meet this want by describing the useful bacteria of the dairy industry so thoroughly that it may be possible in the future to identify the strains encountered." Of the many hundreds of organisms studied, the work on 330 representative strains is included in the report. The bringing together of strains on the sum of their characteristics has been his guiding principle. He shows how essential is the nature of the nitrogen source of the media employed, and his tables indicate the pronounced success which has followed the using of his casein digest media. His more important considerations are the study of morphology, the quantitative determination of acid production in eighteen carbo-hydrates and in milk, the degree to which the strain can form soluble nitrogen, and amino nitrogen after incubation in chalk milk, and the type of lactic acid—dextro, laevo or inactive that is formed. He emphasizes that none of the studies in the investigation can be dispensed with, and that no one characteristic of these can be taken as being of decisive importance: ...."Only by taking note of all qualities can we arrive at a natural bacterial system." As he observes, only the most constant qualities can be used as a species character. Hence, all the characteristics of his strains were tested, again and again, through a period of ten years. No claim is made that the classification of the lactic acid bacteria has been settled in detail. The claim is made, and justly so, that the permanent structure within which the newer systematic work will find its place has been constructed.

I spent eight crowded months on the determinations defined, and on the consequent interpretations. It is an absorbing study. One knows something of one's strains when the work is done; and one is led to the emphatic conclusion that, to the systematist and the applied bacteriologist alike, this work of Orla-Jensen is indespensible.

The excellent photo-micrographs, of themselves, are of intense interest: there are 18 of *Streptococcus lactic,* 32 of *Streptococcus cremoris,* 34 of *Streptobacterium casei,* and 4 of *Thermobacterium helveticum* included in the total of 279 photographs of bacterial strains presented.

At the present time, the study of many other strains, some appearing to be intermediate between the species already defined, is in progress, and further data may be available in the near future.

A rather shy man is Orla-Jensen, modest, almost to a fault, yet dogged and tenacious when principle and convictions are at stake; quick in perceiving the essence of a thing, with natural genius as an observer. Still in his prime, he represents the history of the science he adorns and, at the same time, embodies that which constitutes a mecca for those who seek guidance in the pursuit of productive research. To those who know him well, and know his work, he is not only a master of the craft; he is an institution. His monumental work, for it is no less, is his monograph on "The Lactic Acid Bacteria." To contemplate, study, and analyse this monograph with the man himself, week in and week out, month in and month out, and the relation to it of the current data piling up on one's own bench, is an experience and a stimulation not to be missed, and not to be forgotten.

Speaking to a Canadian Society, and discussing Freudenreich and Orla-Jensen, one finds oneself thinking of the man who, in our own country, has had the closest connection with Freudenreich as a master, with Orla-Jensen as a contemporary and who finds himself at home in the present setting—Professor F. C. Harrison of McGill University. In more than one phase of bacteriology Harrison has been, and is, the most distinguished worker that Canada has had for a quarter of a century. Agricultural, and in particular, dairy bacteriology in Canada had its inception in Harrison. For many years he made Guelph and Macdonald College familiar names in the leading laboratories in Europe. Let us not forget that in Harrison we have the heritage of Freudenreich and the association of Orla-Jensen as the background, in part, to the profound erudition and outstanding accomplishments of the leading Canadian worker in his field.

From Copenhagen I went to Sweden, working with Professor Barthel at Experimentalfältet.

In approaching Sweden one must first make reference to the contributions which for so many years have been made by Professor Rosengren, now retired, of Alnarp. His influence on the development of dairying research and practice in Sweden cannot well be over-estimated; while his own researches, and those published in collaboration with Barthel, Haglund and others speak for themselves.

The principal reason for seeking to work with Professor Barthel was that I might be in touch with the important and fundamental work he is doing on the influence of the Streptococci in the ripening of cheese. I found him, with his collaborator Professor Haglund and a staff of assistants, engaged on researches into the influence of the Streptococci on the ripening of a cheese commonly made in Sweden. Barthel projects Orla-Jensen's enzyme theory with respect to the Lactic Acid Rods into the consideration of the Lactic Acid Streptococcus group. He believes that a wider significance than has formerly prevailed must be attributed to the rôle of the Lactic Acid Streptococci in cheese ripening. It is a theory not without its fascination, and the necessary work involved is being pursued with that cautious vigor characteristic of the man. The organizing of the work, the material equipment, and the ease with which the technique of cheese-making and the chemical and bacterial work contingent thereon can proceed, suggest genius

for administration. I think that the manner in which the research is proceeding is the finest example of the value of co-operative activity, under sound direction, I have seen in any institution.

As yet the data on the major research, now proceeding, cannot be made available. But the earlier stages of the enquiry can be followed from the publications issued during the past few years by Barthel, Haglund and Sandberg. Barthel has shown that the temperatures usually employed in storing the cheese on which the work is being done, (14° - 20°C), suit certain of the Streptococci in so far as their casein-splitting abilities are concerned. As to this finding, one should cite Orla-Jensen ("The Lactic Acid Bacteria," p. 111)..."but also the casein-splitting strains of *Sc. lactis* and *Sc. cremoris* gave an extremely good cheese, so that we can willingly agree with Barthel that a greater importance should be ascribed to such streptococci in the ripening of cheese than has hitherto been conceded." These researches, participated in and directed by Barthel, are of the utmost importance. For the ultimate results we must wait. But the work promises to be the most significant contribution to the solution of cheese-ripening being made at the present time.

Laboratory workers would do well to make themselves familiar with Barthel's methods for keeping stock cultures of the Lactic Acid Streptococci in chalk milk and in sterilized soil respectively. At the present time he has four *Streptococcus lactis* strains alive and vigorous, growing in chalk milk, two having been inoculated in 1915 and two in 1918. In sterilized soil he has some strains which, without re-inoculation, have remained active for eight years. He has found that *Thermobacterium helveticum* (Orla-Jensen) cannot be carried in this manner.

One recent contribution of Barthel's should be made available in English. In "Om Mjölk och Mjölkhushållning" under the general editorship of Professor Rosengren, Professor Barthel contributes a long, critical, and illuminating review of the present state of knowledge of the bacteriology of milk and milk products, placed in the proper historical setting. It is hoped that some way may be found whereby we may get access to the work.

It would be difficult to find a more stimulating and understanding chief, colleague or associate than is Barthel. He has the imaginative faculty to a marked degree; a keen, well-ordered, analytical mind, patient and open as the day, quick to perceive the things that matter. He has a profound reverence for the experiences of the past; yet the new finding which, when confirmed, appears to strike at principles accepted as stable, invariably attracts him as a magnet. With a buoyant, almost boyish enthusiasm, tempered with a cautious, conservative, contemplative quality of mind, he pursues his course.

Among the younger workers in Northern Europe, two in particular bid fair to fill no mean place: the one is Dr. Virtanen of the Valio Laboratory, Helsingfors, Finland; the other is Professor Søncke Knudsen of the Royal Agricultural College in Copenhagen.

PLATE I

1 Docent Nils Fjord. 2. Professor Barthel. 3. Dr. Ed. von Freudenreich. 4. Professor Orla-Jensen. 5. Dr. V. Storch.

For me to discuss Dairy Bacteriology in Scandinavia without referring to an American colleague whose name is familiar to many of you is an impossibility. I refer to Professor George Hucker, the Associate of Professor Breed at Geneva (Cornell University). For many months, Hucker and I were co-workers in Orla-Jensen's laboratory in Copenhagen, and I am simply passing on to you the comments of those in a position to know, when I suggest that in the field of dairy bacteriology we shall do well to keep our eye on Hucker.

Some other time, and in some other place, an opportunity may present itself for an adequate treatment of the application to the industry of the researches of those whose work has been discussed.

Let me conclude.

I found the time spent with Professor Orla-Jensen and with Professor Barthel thought-provoking, illuminating and stimulating. Since coming back, and thinking over the year, it has seemed that they gave me not only the freedom of their laboratories, but, what is more, that they permitted me to enter into their thinking processes, and, as far as in me lay, to share their mental outlook. The treatment and consideration I received could scarcely be matched.

When the privilege that was mine is enjoyed by others, it will be found that one must not pass through these laboratories in a hurried time-is-pressing manner; one must loiter a little, one must wait a while, one must live oneself into the atmosphere and learn to breathe the air.

In their work it is the essential and the fundamental that make the appeal. A too hurried attempt at a too previous application is anathema. May I be permitted an observation: occasionally a feeling may exist that at times, in certain cases, some of us in the newer countries may be a little too ready, a little too eager in publishing our work and in presenting our interpretations, but at times only—only in some cases. For nowhere does one find a more profound respect and appreciation accorded to the good solid work that has come out of North America than is to be found in these laboratories of Northern Europe.

We on this continent are becoming impressed with the necessity of those of our own students who engage in the field of dairying concerning themselves, more and more, with the basic sciences and, possibly, with chemistry in particular. Over there the insistence on a knowledge of the fundamental sciences is emphatic; and no more outstanding examples can be found of the validity of such insistence than Orla-Jensen and Barthel themselves.

As is the case in the best of our own institutions, one finds that while buildings are important, the man is the first consideration. One finds that the organization must not be too rigid, lest it limit the individuality and genius of the man; that admittedly the organization, in a measure, grows out of the needs of the man; that the man is not molded to fit the machine.

Each of the two with whom I worked has made, and is making, most distinctive and distinguished contributions in his field; each has that quality of mind that illuminates the thing he touches; each with perception and intuition sees the next step, and the next; and, when the path has been defined, each, as in a fever of vigor, goes ahead.

May it not be that these qualities have freer rein where men will take the time to do their thinking in the quiet? May it not be that more and more, as they, we shall feel and heed the need of the

Hush, hush, hush,
Tell the wind it mustn't blow:
And ask the chattering squirrels there,
To whisper very low?"

University of British Columbia,
Vancouver, B.C.

BOOK REVIEW

Biochemical Laboratory Methods for Students of the Biological Sciences. By Dr. C. A. Morrow. XVII + 350 pp., 27 figs. John Wiley and Sons, New York, 1927. $3.75.

Here is a manual which should not only help greatly in the development of laboratory instruction, but should also prove of great value to research workers in any branch of soil, plant, or animal science, whose problems lead them into the borderland science of biochemistry. The 233 experiments include directions for a wide range of preparations, and many analytical methods, both qualitative and quantitative. The descriptions are prepared with unusual care and completeness, and at the end of each experiment is appended a list of the more important cognate references. Unusual or special apparatus is in several cases illustrated by figures.

The experiments are grouped in nine chapters, covering the following topics: the colloidal state, physical-chemical constants of plant saps, hydrogen-ion concentration and buffer action, proteins, carbohydrates, glucosides, fats and allied substances, enzymes, plant pigments. A complete list of the experiments given in the table of contents, together with author and subject indexes, make the contents readily accessible.

Dr. Morrow was a member of the Division of Agricultural Biochemistry at the University of Minnesota. His book, which was published posthumously, was the result of nine years' development of laboratory methods by himself and his associates. In view of the distinguished researches in the fields of colloids, proteins and plant biochemistry, which have been carried on in that laboratory, it is not surprising to find the treatment of these major phases especially complete and satisfying. The book is unique in its scope, and must prove an invaluable asset to teachers in this new field, as well as a convenient starting-point for young researchers.

R. N.

LE PREMIER CONGRES INTERNATIONAL DE LA SCIENCE DU SOL, A WASHINGTON.

Pour le profane, il peut paraitre exagéré de consacrer un congrès d'une durée de 9 jours, suivi d'un voyage d'étude d'un mois à travers tout le continent américain, à la science du sol.

Le grand public s'imagine encore trop facilement, en effet, que l'étude du sol peut se circonscrire dans les limites étroites de quelques analyses chimiques ayant pour objet le recherche et le dosage des trois ou quatre éléments de fertilité essentiels à la croissance des récoltes, dont le nom et les propriétés sont restés plus ou moins familiers à ceux dont l'instruction fut assaisonnée de quelques notions de chimie élémentaire.

Mais tous ceux qui sont un peu au courant de l'état actuel de la science en agriculture savent les développements énormes qu'a pris l'étude du sol depuis une vingtaine d'années surtout, en dehors du domaine de la chimie traditionnelle où elle a évolué pendant si longtemps après les grandes découvertes fondamentales des Liebig, Boussingault, Lawes et Gilbert et autres savants contemporains. Aux travaux de la chimie physique, à partir du commencement de notre siècle, se rattache notamment un nouvel essor de la science du sol dans tous les pays, indépendamment de l'importance plus ou moins grande qu'y prennent la bactériologie et la géologie. C'est ainsi qu'il devient difficile de se tenir au courant des seuls travaux qui se font sur la question de l'acidité du sol, aujourd'hui, pour se rendre compte de la complexité de ce chapitre que l'on croyait pouvoir résumer en une couple de paragraphes il y a quelques années.

Cet intérêt croissant suscité par l'étude scientifique du sol dans les différentes contrées du monde amena, en 1909, la réunion d'une première conférence internationale d'experts en cette matière, à Budapest, suivie d'une deuxième à, Stockholm, en 1910. St-Pétersbourg fut fixé comme siège d'une troisième conférence, mais le projet fut mis à néant par l'explosion de la guerre mondiale et ce ne fut qu'en 1922 qu'elle put être tenue à Prague, lorsque les rancunes et les défiances engendrées par la longue lutte commencèrent à se calmer. Une quatrième réunion eut lieu à Rome, en 1924, et fut marquée par la fondation de l'Association internationale pour la Science du sol", et la résolution de réunir en l'année 1927 le premier congrès international de la science du sol à Washington. L'organisation de ce congrès fut entreprise par l'association nouvellement créée, avec le concours de l'American Society of Agronomy et le Département de l'agriculture des Etats-Unis.

Pour donner immédiatement un aperçu de l'amplitude des domaines occupés actuellement par les travaux scientifiques relatifs au sol, il suffira d'ailleurs de procéder à l'énumération, d'après le programme officiel, des six commissions différentes ayant siégé séparément ou simultanément au cours du congrès de Washington:

1o Commission : *Etude du sol au point de vue physique et économique.*
2è " : *Etude de la chimie du sol.*
3è " : *Biologie et biochimie du sol.*
4è " : *Fertilité du sol.*
5è " : *Classification, nomenclature et cartographie des sols.*
6è " : *Application de la science du sol à la culture du sol.*

Durant tout le congrès, trois matinées seulement furent consacrées à des séances générales réunissant tous les congressistes. Pour le reste il y avait donc obligation de faire son choix entre l'une ou l'autre commission. suivant la prédominance de l'intérêt d'un chacun. Ceci revient à démontrer que la science du sol a pris des proportions beaucoup trop grandes pour être embrassée en une seule spécialité par le même homme. Les savants et les chercheurs de premier plan ne se rencontrent donc plus que dans l'une ou l'autre des subdivisions de la science du sol indiquées par l'énumération des différentes commissions. Aussi n'avons nous pas la prétention de vouloir donner un rapport de ce congrès dont, à part les sessions générales, il nous fut donné seulement de suivre les réunions de la cinquième commission, s'occupant de la classification, nomenclature et cartographie des sols. Ceux que la matière intéresse pourront d'ailleurs, d'ici à quelques mois, puiser à satiété dans les volumineux rapports officiels qui ne manqueront pas d'être publiés.

Le but de ces notes est donc tout simplement de donner quelques impressions générales du premier congrès international de la Science du sol tenu à Washington et de la grande excursion transcontinenttale faite principalement pour avoir un aperçu des régions ou provinces agro-géologiques que l'on peut distinguer sur le continent américain et trouver ainsi matière d'application aux travaux discutés dans la cinquième commission.

Le cadre du Congres

Washington, capitale fédérale, placée dans ce minuscule District de Columbia afin d'en assurer l'indépendance complète de tous les autres états de la grande union américaine, est certainement un endroit idéal pour la tenue des nombreux congrès qui s'y succèdent lorsqu'ils ne s'y réunissent pas simultanément. Ville d'un demi million d'habitants environ, qui ne doit son importance qu'aux ministères, services publics et ambassades, avec la foule des dignitaires, fonctionnaires et employés civils que cela implique, son atmosphère n'est jamais obscurcie par les fumées d'usines pratiquement inexistantes et non tolérées, d'ailleurs, dans ses limites. Des autres cités des Etats-Unis elle diffère encore avantageusement par le plan général, qui s'écarte du sempiternel système de rues se coupant à angle droit qui divisent le tout en ces monotones blocs, tous si semblables de New York à San Francisco, qu'on peut dire qu'il n'y a rien qui ressemble autant à une ville américaine qu'une autre ville américaine. Ici, ce sont des avenues partant du centre, comme les rayons d'un moyeu de roue, qu'a tracées l'architecte français, Pierre Charles l'Enfant, officier du génie, attaché à l'état major du général Washington. Le plan était conçu de façon à permettre des agrandissements et des embellissements successifs, en rapport avec le développement en richesse et en puissance de la grande nation américaine.

Notons toutefois que celui qui donna une si belle leçon de bon goût en concevant le projet grandiose de la capitale fédérale des Etats-Unis ne fut guère compris de ses contemporains; méconnu, il mourut dans la pauvreté et son oeuvre ne fut reprise que plus tard par un nommé Alexander Shephard, appelé par le président Grant au poste de gouverneur du territoire fédéral. Une expression de tardive reconnaissance a fait transporter les restes de Charles l'Enfant au cimetière d'Arlington, où un monument lui fut élevé.

Aujourd'hui, dans l'oeuvre achevée de l'architecte français, nous pouvons admirer ces parcs placés à nombre d'insections des avenues plantées de grands arbres, comme autant de stomates sur le parcours des nervures d'une feuille, où la population peut respirer l'air en abondance, sous de frais ombrages, au pied des statues de héros de la guerre d'indépendance et d'autres citoyens éminents, qui ornent habituellement ces endroits. Remarquons, d'ailleurs, que le climat chaud et humide dont jouit la capitale de la grande république, joint à un sol graveleux et profound, semble particulièrement favorable à l'épanouissement d'une foule d'essence ligneuses qui ne résisteraient pas aux conditions rigoureuses de la latitude de la province de Québec.

Les perspectives grandioses ménagées dans le plan général de l'élégante ville baignée par l'estuaire de la Potomac et entourée de collines boisées sont nombreuses, et la plus remarquable est certainement celle qu'on découvre de la colonnade de l'imposant monument de style grec, élevé à la mémoire du président Lincoln, qui fait voir, en un seul alignement, une vaste pièce d'eau, le grand obélisque édifié en l'honneur de Washington, le beau parc et la resplendissante coupole du capitole.

Pourtant, les palais somptueux érigés en ces dernières années contrastent assez fortement avec la simplicité de bon aloi de la Maison Blanche, résidence traditionnelle des présidents qui fait plutôt penser à un château de campagne bien tenu en France, et témoignent de l'opulence débordante des temps actuels. "Il faut avoir habité Washington, dit Georges Bernard Lévy, dans un article paru dans l'Illustration du 24 septembre 1927, pour en connaitre l'intérêt et le charme. Le monde diplomatique, le haut personnel des ministères, le corps de savants des laboratoires du gouvernement, les dirigeants des grandes institutions nationales: Smithsonian Institution, musées, bibliothèques, les visiteurs de marque, les groupements fédératifs d'arts et de métiers font de Washington un centre policé où la bonne société aime à se rencontrer et à se fréquenter. Washington est, en vérité, l'Athènes du nouveau monde. Reliquaire du passé, dépositaire de l'avenir, la capitale nationale déroule son histoire parmi les dons les plus magnifiques de la nature."

Parmi les palais récents, surgis comme par enchantement dans ce beau décor, figure l'édifice de la Chambre de Commerce des Etats-Unis; et ce fut dans ses salons mis à la disposition du comité organisateur que se déroulèrent les séances du congrès international de la Science du sol.

Les Delegations au Congres

Plus de trente nations du monde étaient représentées par environ 500 délégués à ces assises où devait être étudiée et discutée sous tous ses aspects

l'assiette même de la production agricole de l'univers. Si l'on fait abstraction de la délégation des Etats-Unis, la plus imposante était certainement celle de la Russie, figurant sous le titre officiel "d'Union des Républiques Socialistes Soviétiques," qui avait envoyé un contingent de plus de vingt professeurs et spécialistes conduits par le célèbre professeur Dr. K. D. Glinka, de Pétrograd, décédé au mois de novembre dernier, savant déjà bien connu sous le régime tsariste et dont la valeur exceptionnelle a été reconnue même par le régime actuel.

Après cela venait l'Allemagne, avec une douzaine de délégués, parmi lesquels il y a lieu de mentionner le Dr. Albert Penck, de l'université de Berlin, célébrité bien connue en géographie physique; le Dr. O. Lemmermann, de l'université agricole de Berlin, dont le nom revient si souvent dans les travaux de chimie du sol faits au cours des dernières années; le Dr. Herman Stremme, de l'université technique de Dantzig, bien connu pour ses travaux en matière de classification des sols, etc. La Pologne avait cinq ou six représentants, tous fort sympathiques, dont le plus imposant était le géant débonnaire, Dr. Niklazewsky, professeur à l'université de Varsovie.

Parmi les nations n'atteignant pas ce chiffre, citons encore la Hongrie, avec le Dr. Von Sigmond, petit homme fluet mais vif, professeur à l'université de Budapest, qui était le populaire président de la 2ème commission, pour l'étude de la chimie du sol, et le Dr. Peter Treitz, de Budapest également, qui s'est distingué par ses travaux dans l'agrogéologie; la Hollande se mettait en évidence par le Dr. D. J. Hissink, de l'Institut de Science du sol de Groningue, et secrétaire de l'association internationale pour la Science du sol; la Suisse, l'Italie, le Danemark et la Suède qui étaient représentés chacun par quatre ou cinq délégués; le Japon, avec trois représentants. La représentations de l'Angleterre brillait par la présence de Sir John Russell, directeur actuel de la célèbre Station expérimentale de Rothamsted, dont l'aménité cordiale et l'humour toujours en éveil contrastaient avec le flegme et la réserve habituelle des autres délégués de la Grande Bretagne.

Remarquons avec quelque dépit que le France et la Belgique, vraisemblablement pour des raisons de compression budgétaire, que dans tous les pays on semble appliquer en premier lieu aux crédits affectés à l'agriculture, n'avaient personne pour venir parler au nom de leur science à ces assises internationales. Cet effacement était évidemment fort regrettable, tant au point de vue du prestige de l'agronomie française que des avantages que le congrès lui-même eut pu retirer des travaux de ses savants.

Des délégués de nations sympathiques à la France, telles que la Pologne et la Roumanie, le firent très justement remarquer. C'est ainsi que le Dr. Théodore Saidel, professeur à l'Institut de géologie de Bucharest, distingué représentant du dernier pays, m'exprimait le regret de l'abstention des savants français en estimant que leur présence eut été précieuse pour les résultats. Leur tournure d'esprit synthétique et pleine de précision, dit-il, eut plus d'une fois formulé des conclusions nettes et claires à l'occasion de certaines discussions qui menaçaient de devenir un peu confuses. Cette simple réflexion implique certes un bel hommage à une qualité primordiale de la science française.

Seances et Travaux des Commissions

Il ne peut évidemment être question de donner ici un aperçu des 400 sujets qui furent présentés et discutés au cours des séances pléinières ou dans les réunions des six commissions siégeant séparément. Disons seulement que chaque congressiste reçut, en s'inscrivant, les résumés de tous les travaux figurant au programme, imprimés en trois volumes et traduits en trois langues: anglais, français, allemand, et parfois même italien ou en espagnol, de manière à pouvoir faire un choix dans cette vaste matière et suivre facilement les discussions. Nous nous contenterons donc de dire quelques mots des conférences d'intérêt général faites pendant les séances plénières et d'entrer dans quelques considérations sur les activités de la Vème commission, pour la classification et la nomenclature des sols, à laquelle nous nous sommes intéressés plus spécialement.

Marqué par une discours d'ouverture de l'Honorable Calvin Coolidge, président des Etats-Unis, le lundi 13 juin à 2 heures p.m., le congrès n'aborda les travaux effectifs que le lendemain 14 juin, à 9.30 a.m., par une remarquable conférence de son Président général, le Dr. J. G. Lipman, professeur au collège d'agriculture de New Brunswick, état de New Jersey, qui avait choisi un sujet d'introduction intitulé: "L'homme et la terre."

Le texte français de ce travail a déjà été publié dans la Revue agronomique canadienne, il suffira donc de renvoyer les lecteurs au numéro du mois de septembre 1927, de cette revue, dans lequel ils pourront prendre connaissance de l'exposé plein de profondeur de pensée par lequel le Dr. Lipman nous fournit, avec une foule de données numériques à l'appui, les rapports qui existent entre les ressources du sol et de l'atmosphère en éléments constitutifs de la matière organisée et les possibilités de développement matériel de l'humanité à la surface de notre planète.

La séance plénière du mercredi 15 juin fut particulièrement bien fournie. On y entendit d'abord le Dr. A. F. Woods, directeur des travaux scientifiques du Département de l'agriculture des Etats-Unis, qui parla de l'origine et des buts du Bureau des Sols. La traduction française de la conférence du Dr. Woods a également paru, dans le numéro du mois de novembre 1927 de cette Revue. Ensuite ce fut le tour à Sir John Russell, directeur de la Station expérimentale de Rothamsted, de nous exposer, avec cette simplicité qui caractérise souvent le véritable savant possédant son sujet à fond, l'état actuel de la biologie du sol et de ses relations avec l'agriculture pratique.

On pourrait résumer comme suit les traits principaux de la conférence du Dr. Russell.

Pour l'agriculture pratique, l'importance de la biologie du sol réside en premier lieu dans la transformation des matières organiques de la terre par les micro-organismes et en deuxième lieu dans l'action directe que ceux-ci exerçent sur les plantes en voie de croissance.

Les modifications dans la matière organique du sol peuvent être produites d'abord par apport de substance organique au sol par fixation d'anhydride carbonique par les bactéries, d'azote gazeux par les azotobacter, les clostridium etc., d'ammoniac et de nitrates par un grand nombre d'organismes; et en deuxième lieu par la dégradation de la substance organique. Cette dé-

Examen d'un profil, au cours du voyage d'étude du Congrès international de la Science du Sol, dans les Etats Unis.

gradation peut s'effectuer de quatre manières: 1o Par la dissolution des éléments structuraux des cellules des plantes mortes, avec destruction des matériaux fibreux grossiers, ce qui dans certaines circonstances exerce une action physique nuisible sur le sol. 2o Par la formation de substances organiques colloidales qui généralement sont avantageuses pour le sol. 3o Par la transformation de composés organiques complexes, impropres à la nutrition des plantes, en composés simples d'azote, de phosphore et de soufre facilement assimilables pour les plantes. 4o Par la destruction de composés nocifs pour les plantes, qui prennent naissance au cours des transformations indiquées plus haut.

Ces transformations, dont la portée est très étendue dans leur effets, exercent notamment un rôle considérable par rapport à la composition de la solution du sol.

Russell distingue deux sortes de rapports entre les organismes du sol et les plantes: 1o Des rapports symbiotiques, lorsque l'organisme prend part à la nutrition des plantes, ainsi qu'on l'observe particulièrement chez les légumineuses et les plantes associées avec les mycorrhizes. 2o Parasites, lorsque les microorganismes s'attaquent directement aux tissus des plantes et les altèrent de telle sorte qu'ils ne puissent plus remplir leur rôle originel.

Le directeur de Rothamsted fait aussi ressortir que la microbiologie du sol a déjà trouvé des applications pratiques à l'agriculture dans quatre directions différentes: L'innoculation des légumineuses introduite par Hiltner, développée dans les pays scandinaves par Barthel et Christensen, est pratiquée sur une grande échelle dans ces pays ainsi qu'en Angleterre et aux Etats-Unis. La stérilisation partielle des sols est d'une application générale dans les serres aux Etats-Unis aussi bien qu'en Angleterre. De même la préparation artificielle de fertilisants au moyen de boues d'égout activées et de matériaux cellulosiques, tels que la paille, en association avec des matières de vidange est entrée dans la domaine de la pratique. D'autres applications intéressantes de la bactériologie dans la fertilisation du sol sont la préparation de composts de matières humifères avec du soufre et des phosphates, et la production de fumier synthétique par la décomposition biochimique de la paille.

A la même séance, la professeur Dr. Lemmermann, de l'université agricole de Berlin traita du "Problème des acides du sol." A ce propos il communiqua les résultats d'expériences sur parcelles de l'Institut de chimie agricole de l'université de Berlin, à l'effet de déterminer l'action de plusieurs engrais à caractères chimiques différents, sur la réaction du sol et le rendement des récoltes.

Les principales conclusions de ces essais sont formulées comme suit par l'auteur. Dans un sol sablo-argileux, à faible teneur en chaux dans la couche arable, légèrement acide, il fut trouvé:

a/ Que pour des applications d'azote, d'acide phosphorique et de potasse, en quantités égales, la réaction des engrais exerça une grande influence sur le rendement des récoltes. Ainsi les plus hauts rendements en pommes de terre furent obtenus avec une combinaison d'engrais possédant une réaction acide; en orge et en betteraves sucrières avec une association

d'engrais à action alcalinisante. Les mélanges d'engrais à action neutre fournirent des résultats intermédiaires entre ceux des fertilisants acides et alcalins.

b/ Les différentes formes d'engrais exercèrent aussi leur effet sur la réaction du sol. C'est ainsi que l'application conjointe de phosphate Thomas et de nitrate de soude neutralisa la réaction acide du sol en question.

Signalons aussi la conférence du Dr. A. Penck, le professeur de géographie physique bien connu, de l'Université de Berlin, faite à la séance générale du vendredi 17 juin, intitulée: *La capacité productive du globe.* Le professeur expliqua une carte, conçue par lui, indiquant la capacité productive des espaces cultivables, en fonction du nombre de calories qu'il est possible d'en extraire dans les conditions les plus favorables. De cette façon, il arrive à établir une limite de développement de la population mondiale. Alors qu'il y a 150 ans Malthus prétendait déjà que l'accroissement de la population suivant une progression géométrique contre celui des ressources alimentaires suivant une progression arithmétique, devait fatalement déterminer une famine générale dans un avenir rapproché, s'il n'intervenait une limitation de l'augmentation de population, l'accomplissement du 19è siècle ne vit pas se réaliser la prophétie de Malthus. Cependant ce dernier siècle fut témoin d'un doublement de la population du globe, mais aussi d'un accroissement énorme des surfaces en culture et d'une augmentation de rendement de plus du double par unité de surface, dans beaucoup de pays.

Quelques savants ont fixé au chiffre de deux milliards et demi la limite de population de la terre et redoutent des avant la fin du 20e siècle un excès de population, qui doit mener rapidement l'humanité vers une catastrophe.

A l'encontre de ces estimés, Penck est d'avis que huit milliards d'êtres humains pourront trouver leur subsistance matérielle, en cas d'utilisation complète des surfaces cultivables.

En admettant une même mesure dans l'accroissement de la population qu'au cours du 19e siècle, les conditions deviendront telles qu'au bout de 200 ou 300 années la production des régions tempérées sera insuffisante pour nourrir l'humanité et qu'il faudra s'adresser aux régions tropicales, telles que le bassin de l'Amazone et la Sibérie orientale, qui actuellement sont encore en friche, pour suppléer aux besoins d'aliments. La possibilité d'augmenter la production des pays tropiques est démontrée par la population extrêmement dense de l'ile de Java. De tous les pays du monde, c'est le Brésil qui jouit de la perspective de devenir la contrée la plus populeuse. Alors que durant le 19e siècle l'acroissement des étendues cultivables s'est fait surtout aux dépens des forêts dans les régions tempérées, on peut s'attendre à ce qu'il se continue dans l'avenir principalement par le défrichement des forêts tropicales.

Activities de la 5e Section

Classification et nomenclature des sols

Les réunions de cette commission présidée par le Dr. Marbut, chef du "United States Soil Survey", furent particulièrement bien suivies. Grand, mince, avec un profit de médaille sous le toupet qui blanchit, des yeux pétil-

lants qui éclairent le sourire bon enfant, toujours prêt à se dépenser au cours de son astreignante charge de conduire des débats entre hommes parlant toutes espèces de langues, pour interpréter, traduire, expliquer et résumer, par la parole, et par gestes lorsque celle-ci ne suffit plus, les travaux présentés, les questions et les réponses qu'ils suscitent, le président de la 5e section ne tarda pas à acquérir une popularité très grande au sein de cette foule internationale, popularité dont les manifestations spontanées et exubérantes éclatèrent plus d'une fois durant le congrès et surtout au cours de la grande excursion transcontinentale qui en fut la prolongation. On peut dire que les travaux de cette 5e commission furent dominés par les délégations russe et allemande; en outre il y a lieu de mentionner la part qu'y prirent, sans compter les Etats-Unis, les représentants de la Pologne, des pays Scandinaves, de la Hongrie, de la Roumanie et du Canada.

Les conférences et les discussions se passèrent presque exclusivement en anglais ou en allemand surtout, langue qui en dehors de pays germaniques est encore généralement comprise par les savants des autres nationalités de l'est et du nord de l'Europe.

Un grand nombre de communications furent faites concernant les profils de sols étudiés suivant les méthodes récentes de classification, et il fut présenté de nombreuses cartes agrogéologiques de différents pays élaborées en ces derniers temps.

Ainsi, il y aurait lieu de mentionner particulièrement la nouvelle carte des principaux types de sols de l'Europe, publiée par une sous-commission de la cinquième section, sous la direction du professeur Stremme, de Dantzig. Furent encore présentées une nouvelle carte agrogéologique de la Russie d'Europe, celle de la Hongrie, par Peter Treitz, celle de la Roumanie, par le professeur Th. Saidel, de Bucarest, de la Pologne par le professeur Miklazewski, de Varsovie, et beaucoup d'autres.

Le Canada fit part aussi de travaux de classification effectués dans son territoire, mais dans les provinces de l'Ouest seulement.

C'est ainsi que le professeur A. H. Joel, de l'Université de Saskatoon présenta une étude intitulée: "Les profils prédominants de la Saskatchewan et leurs relations avec les facteurs qui affectent le développement des sols dans les latitudes septentrionales."

Le professeur Wyatt, du collège d'agriculture d'Edmonton, fit la description de quelques profils typiques rencontrés dans l'Alberta.

Une partie importante des discussions porta naturellement sur les facteurs de classification des sols et leur importance relative. On sait que l'Ecole russe, dont Dokutchaeff fut le fondateur et Glinka le continuateur, attira l'attention sur l'importance des conditions climatiques comme base de classification des sols. Il apparait même parfois que, par un effet de réaction fréquent dans des circonstances analogues, c'est-à-dire lorsque l'importance d'un fait inconnu ou négligé jusqu'ici s'impose, les agrogéologues russes en arrivent à mettre dans l'ombre d'autres facteurs de classification qui conservent cependant toute leur valeur, à force d'insister sur le rôle du climat dans la genèse et l'évolution du type de sol.

C'est ce que fit ressortir le professeur J. Hendrick, de l'Université d'Aberdeen, en Ecosse, par une comparaison tirée du domaine de la physiologie, lors d'une discussion soulevée au cours du travail lu à la cinquième commission, ayant comme titre: "La composition minérale du sol considérée comme facteur de classification," Je pense, observa le professeur écossais, qu'il en est actuellement un peu du facteur climatique dans la classification des sols, commme il en fut de la question des vitamines il y a quelques années. La révélation de toute l'importance de ces agents de la nutrition, que l'on soupçonnait à peine autrefois, frappa vivement les esprits; il en résulta que beaucoup de gens s'imaginèrent que les autres bases d'appréciation de la valeur des aliments, telles que le pouvoir dynamogène, perdaient de leur importance et qu'il n'y avait plus que la teneur en vitamines qui comptat. Aujourd'hui les choses ont été remises au point, et sans préjudice pour l'importance attribuée aux vitamines, on a rendu aux autres facteurs classiques d'appréciation des aliments la place qui leur revient dans la physiologie.

N'en serait-il pas de même dans la classification des sols. Quel que soit l'intérêt du facteur climatique dont l'importance n'a été comprise qu'après celle des autres, il ne fait que s'y ajouter mais ne les amoindrit pas. Aussi j'estime que la composition minérale ou l'origine géologique du sol conserve toute sa valeur comme facteur de classification.

Pour terminer ce qui est relatif au congrès proprement dit, disons aussi quelques mots de l'exposition organisée dans différentes salles de l'édifice de la Chambre de commerce, pendant sa durée.

Cette exposition comportait d'abord tout un assortiment d'appareils destinés à l'analyse physique et chimique des terres, des spécimens de la flore et de la faune du sol, ainsi que tout le matériel employé dans l'étude biologique et chimique des terrains.

On y remarquait encore toute une collection de la littérature scientifique américaine concernant les sols, et un grand nombre de cartes agrogéologiques, de coupes de diagrammes et de dessins se rapportant aux sols des différentes parties du monde. Dans ce domaine, les profils de sols des différentes régions agrogéologiques de la Hongrie, avec les associations de plantes s'y rapportant suscitèrent un intérêt particulier.

Mais la principale attraction de cette exposition résultait incontestablement de la série de monolithes des principaux types de sols de la Russie, des Etats-Unis et de plusieurs autres pays.

Ces monolithes découpés avec soin dans des tranchées de sols étudiés, puis introduits dans des caisses étroites mais longues de six à huit pieds, dont une des parois est formée d'une plaque de verre, permettent d'observer les différents horizons que l'on distingue dans le profil d'un sol considéré d'après les méthodes actuelles de classification.

ACTIVITES DES SECTIONS

Section de Montreal

La section de Montréal désirant manifester sa sympathie à monsieur Narcisse Savoie, secrétaire du Département de l'Agriculture et chef du Service des Agronomes à Québec, à l'occasion de son élévation au titre de "Chevalier du Mérite Agricole", l'avait invité comme hôte d'honneur à son déjeûner-causerie du samedi 24 mars, au Cercle universitaire de Montréal. Monsieur Georges Bouchard, membre de la Chambre des Communes d'Ottawa et professeur à l'Ecole d'Agriculture de Ste. Anne de la Pocatière, avait accepté d'être le conférencier du jour.

Monsieur H. M. Nagant, président de la section de Montréal, au nom des 40 techniciens agricoles qui avaient répondu à l'appel, félicita le sympathique chef du Service agronomique de la Province de Québec et fit remarquer la spontanéité de l'hommage unanime apporté par tous les techniciens en général et les agronomes de district en particulier, au lauréat. Ensuite il présenta le conférencier du jour, monsieur Georges Bouchard, et adressa la bienvenue à Monsieur Ernest Bertrand, substitut du procureur général à Montréal, ami de jeunesse de monsieur Narcisse Savoie, qui avait bien voulu accepter l'invitation de se joindre à cette manifestation intime des techniciens agricoles.

Monsieur Georges Bouchard traita d'un sujet qui lui est cher: "La femme et le problème rural," dans lequel il démontra la nécessité de développer les petites industries à la campagne afin d'enrayer l'exode rural, garder l'intégrité du foyer, surtout en y retenant les jeunes filles qu'attirent trop, de nos jours, les promesses fallacieuses et les vains plaisirs de la ville.

Puis, monsieur Narcisse Savoie, invité à prendre la parole, remercia la Section de Montréal pour les témoignages de sympathie reçus ; il fit aussi l'éloge du corps agronomique dont il est le chef, en dressant le bilan de ses activités dans la province de Québec. Monsieur Nolasque April, agronome officiel du comté de Chateauguay, se fit l'interprête de ses confrères pour exprimer à leur chef les sentiments d'estime affectueuse qu'ils lui vouent et la satisfaction qu'ils éprouvent de le voir à l'honneur. Monsieur April remercia également monsieur Bouchard, au nom de l'assemblée, pour son éloquent plaidoyer en faveur de la conservation du foyer rural canadien, avec ses traditions adaptées aux progrès de la science agricole. Après cette séance, il fut procédé à l'élection du bureau de la section de Montréal pour l'exercise 1928-1929, et à la désignation des délégués officiels à la Convention générale de Québec pour le mois de juin prochain.

L'ancien bureau, composé de MM. H. M. Nagant, Alfred Leclerc et Gustave Toupin, respectivement comme président, vice-président et secrétaire-trésorier, fut réélu.

MM. Elzéar Montreuil, H. M. Nagant, Alfred Leclerc et Gustave Toupin furent aussi désignés pour être les 4 représentants officiels de la section à la Convention générale.

H.M.N.

Section de Ste Anne de la Pocatiere

Réunion du 17 mars

Les agronomes du Bas de Québec ont tenu leur séance d'étude régulière le samedi 17 mars, à l'Ecole d'agriculture de Ste Anne de la Pocatière.

M. J. A. Ste. Marie, régisseur de la Station Expérimentale et président de la section locale, présenta les deux concurrents de la soirée: MM. Paul Carignan et Bruno Potvin, respectivement agronomes de Montmagny et de l'Islet. Le sujet d'étude: "Que faut-il penser de la fédération des Cercles Agricoles"? fut discuté avec beaucoup d'intéret par M. Carignan qui se fit le champion de nos cercles agricoles ordinaires et M. Potvin qui prouva que la fédération des cercles agricoles, sociétés d'agriculture et d'horticulture avait donné de bons résultats dans son comté.

Les assistants s'intéressèrent grandement à la discussion et y prirent part avantageusement à certains moments. En résumé, il faut dire que les cercles agricoles et sociétés d'agriculture fédérés ont des avantages sur ceux qui ne le sont pas et que l'on devrait tendre à grouper lentement les cercles et sociétés d'agriculture de chaque comté de manière à leur faire donner leur maximum d'efficacité.

A la fin de la séance il fut procédé à l'élection de l'exécutif de la section pour l'exercice 1928-1929. Le résultat fut le suivant:

Président, M. l'Abbé F. X. Jean, Professeur à l'Ecole d'Agriculture. Vice-Président, M. Paul Carignan, Agronome Officiel de Montmagny. Secrétaire-trésorier, Elzéar Campagna, Professeur à l'Ecole d'Agriculture. Représentant à l'exécutif central: M. J. A. Ste. Marie, Régisseur de la Station Expérimentale. Délégués officiels pour la convention annuelle: M. Georges Bouchard, M.P., Professeur à l'Ecole d'Agriculture; et M. Florian Champagne, Sous-Inspecteur des Agronomes du District.

E.C.

ELECTION RESULTS

Just as we go to press, we are able to announce the results of the Dominion elections which were conducted by mail ballot during the month of April. The following officers are elected for the year commencing on June 1st, 1928:—

President—E. S. Archibald, Ottawa, Ont.

Vice-presidents—A. T. Charron, Ottawa, Ont., and J. P. Sackville, Edmonton, Alta.

Hon. Secretary—L. H. Newman, Ottawa, Ont.

713 members voted. The ballots were opened on April 30th.

CONCERNING THE C.S.T.A.

Notes and News.

W. F. Jones (Toronto '23), who has been Chief of the Division of Dairy Manufactures with the Dominion Dairy and Cold Storage Branch at Ottawa, has received an appointment as Chief Technical Adviser of the Chateau Cheese Co. Ltd., Ottawa, Ont.

M. A. Watt (Toronto '25), has changed his address to Grand View P.O., Brantford, Ont.

Dr. C. A. Zavitz (Toronto '88), has returned from Florida, where he has been spending the winter months. His address is R. R. No. 2, Ilderton, Ont.

W. G. Hill (Toronto '20), has changed his address to Cameron Avenue, Lansing, Ont.

Antonio Besner (Montreal '23), who has been Assistant County Agriculturist at Victoriaville, P.Q., has been transferred to Village Richelieu, Rouville County, P.Q.

L. C. Young (Toronto '27), is farming at Alliston, Ont., where he is specializing in certified Irish Cobbler potatoes and poultry.

Dr. C. E. Saunders (Toronto '88), moved from Ottawa to Toronto on April 30th. His new address will be 45 Munro Park Avenue, Toronto 8, Ont.

J. H. Robert (Laval '15), has changed his address to Service de l'Horticulture, 2 St. Jacques, Montreal, P.Q.

G. B. Sanford (Alberta '20), is now at the Dominion Laboratory of Plant Pathology, University of Alberta, Edmonton, Alta.

C. E. Lesage (Montreal '22), has changed his address to Department of Agriculture, Quebec, P.Q.

W. Newton (McGill '14), is temporarily at the Dominion Experimental Station, Sidney, B.C.

G. E. Michaud (Laval '15), is now a District Representative at Edmundston, N.B. He has occupied a similar position at Prince Albert, Sask., since 1924.

J. Ficht (Alberta '24), has changed his address to R. 1, Box 120, McKees Rocks, Pa., U.S.A.

Dr. G. C. Creelman (Toronto '88), has returned to his home at Beamsville, Ont., after a visit of six weeks in the Southern States.

Practically all the local branches have held their annual meetings during the past two months. The names of the newly elected officers will be found in the page of this issue showing the organization of local branches. Official delegates to the annual convention have been named by all branches except Manitoba and these are expected within a few days.

The total membership of the Society has been maintained at 1,000 throughout the year which is now closing. No extensive organized membership campaign has been undertaken, and resignations and delinquents have been replaced by new members. On May 1st, 88% of the members are fully paid up and only 12% are owing their fees for the current year. It is hoped that every member will be in good standing when the year ends on May 31st.

Applications for Membership.

The following applications for regular membership have been received since April 2, 1928:—

E. Thomas Goring (Toronto, 1927, B.S.A.), Ontario Agricultural College, Guelph, Ont.
Gordon C. Warren (Toronto, 1927, B.S.A.), Charlottetown, P.E.I.
Arthur H. Joel (Michigan State College, 1919, B.Sc.), University of Saskatchewan, Saskatoon, Sask.
A. Cairns (Alberta, 1923, B.S.), Winnipeg, Man.
E. Massé (Laval, 1921, B.S.A.), St. Germaine de Dorchester, P.Q.
W. E. Lake (Saskatchewan, 1919, B.S.A.), Turtleford, Sask.
S. H. Short (Toronto, 1924, B.S.A.), Ottawa, Ont.
Donald F. Patterson (McGill, 1927, B.S.A.), Truro, N.S.
A. R. Prince (Harvard, 1924, A.M.), Truro, N.S.
J. S. Morrison (Toronto, 1927, B.S.A.), Tillsonburg, Ont.
J. J. E. McCague (Toronto, 1921, B.S.A.), Alliston, Ont.
Kenneth P. Caple (British Columbia, 1925, B.S.A.), Vancouver, B.C.
F. J. Welland (British Columbia, 1923, B.S.A.), Chilliwack, B.C.
J. C. Neale (Toronto, 1917, B.S.A.), Toronto, Ont.

Convention Notes.

This is the last notice regarding reservations. *Rooms at the Chateau Frontenac cannot be secured unless the General Secretary is notified before June 1st.* A special rate of $8.00 per day for double room and bath (two persons) has been obtained, but those who have not made reservations will have to pay $12.00 per day for these rooms—and the chances of getting them are small.

Programmes will be mailed to all members outside of Quebec on May 10th and to Quebec members on May 20th.

It is anticipated that between three and four hundred members will attend the Convention.

In addition to the three lecturers named in the April issue, the following have agreed to give one or two lectures:—(1) Dr. John D. Black, Advisory Committee on Social and Economic Research in Agriculture, Harvard University, formerly Professor of Agricultural Economics at the University of Minnesota, (2) Dr. E. C. Stakman, Professor of Plant Pathology at the University of Minnesota, (3) Dr. J. E. Lattimer, Professor of Agricultural Economics at Macdonald College and (4) Professor H. M. Nagant, Professor of Chemistry at the Oka Agricultural Institute.

Those who can possibly arrange to attend the Convention are urged to do so, *but be sure to make your reservations before May 31st.*